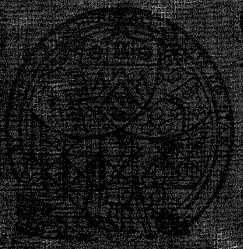

CARPENTER AND BUILDER

TECHNICAL SERIES

No. 18.

Glazing.

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15.—GLAZING.

THE ILLUSTRATED

CARPENTER & BUILDER

SERIES OF

TECHNICAL MANUALS.

Edited by John Black.

"*All that mankind has done, thought, gained, or been; it is lying as in magic preservation in the pages of books.*"

—CARLYLE.

LONDON:
JOHN DICKS, EFFINGHAM HOUSE, ARUNDEL ST., STRAND.

PREFACE.

THIS little treatize on Glazing and Glass is designed, as are also those of the same series, to be a practical manual of the trade it represents. The section was not so long ago scarcely known as a separate industry, and was incorporated in the legend which appeared on most tradesmen's cards as "Plumber, Painter, and Glazier." The progressive nature of the building arts, however, has revolted against such an incorporation, and plumbing and painting have been separated and raised almost to the dignity of science and fine art. In two former books of this same series we have treated of plumbing and of painting. In this one glazing is treated of, and it is found that very much could be said on this trade alone, quite distinct from the others it was allied with. The *Illustrated Carpenter and Builder* has never narrowed its circle so as to include only those two crafts, but has taken a broader field and touched upon as many of the multifarious side subjects as could conveniently be brought within its purview. Glazing is an important trade. It is clear that though a trade cannot be learned from such handbooks as are issued in this series, yet many wrinkles are given in such books as these, which will save much time and trouble even to the journeyman who has learnt his trade, as well as to the apprentice who has yet much to learn. We are glad to find these books so well appreciated, and think that so far as limitations of space permit they cover the ground entirely; but if any question should arise not provided for in its pages, a reference to the paper itself will probably elicit the information, and we are always glad to welcome inquiries, suggestions, and advice from all readers.

CONTENTS.

GLAZING.

CHAPTER I.

THE INVENTION OF GLASS.

THE exact date of the invention of glass is a moot point amongst the chroniclers of technical progress. The ingenious discovery has been accredited to all sorts of personages, mythical and real. The ancient Egyptians claimed it for the fabulous Hermes Trismagistus. That glass of some kind was known amongst that shrewd and clever people is proved by the finding of glass beads in Egyptian mummy-cases, and allusions to it in the writings of Aristotle, Lucretius, and St. John the Divine (in the Book of Revelations) show that glass was known in their time.

Probably the discovery of this useful material was accidental, and there is no unlikelihood in the Roman Pliny's account of the matter. He states that the substance was originated by chance in consequence of some shipwrecked Tyrian mariners lighting a fire on the Syrian shore, where they had been driven by stress of weather, gathering dried "kelp," or seaweed, to form the foundation of their fire, the alkali from the ignited kelp combined with the silica of the sea sand, and when, after their cookery was done, the seamen glanced at the embers, they found therein globules of glass. When they got back to Phœnicia they told their tale, and showed their samples of the novel substance. The news spread, and the inhabitants of the neighbouring city of Sidon perfected the process, and erected the first glass house mentioned in history, and had a monopoly of the manufacture for years.

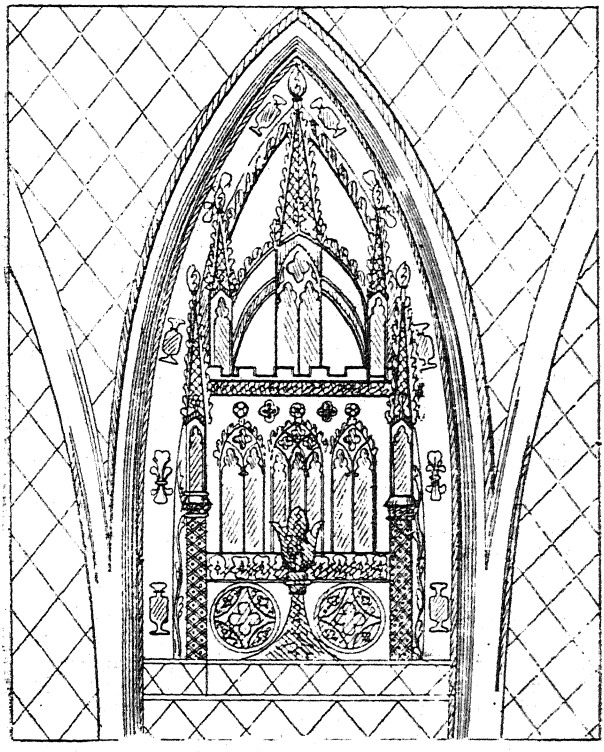
That the ancient Romans knew how to make glass is vouched

for by Pliny, who tells us that an ingenious man, during the reign of the Emperor Tiberius, fabricated malleable or elastic glass, and that the Emperor had him put to death for so doing. Fragments of glass found in Pompeii and Herculaneum prove also that the Romans before our era used glass for glazing. Glass appears to have been known (and probably fabricated) in our own island prior to the Roman occupation. At least, extant relics of the ancient Britons, in the form of glass beads and bowls, lead antiquaries to that conclusion. The remains of British glass are often chromatic, or decorated with bands of colour. During the Saxon period the use of window-glass, like so many other architectural refinements, originated with the Church. Bede, in his "Ecclesiastical History," tells us that Benedict Biscop, Abbot of Monk Wearmouth, brought over Continental workmen to glaze the windows of his church and abbey with coloured glass. This was in A.D. 674. Other authorities attribute the innovation to the same date, but give the credit of it to Wilfrid, Bishop of Worcester.

Save for churches, however, the glazing of windows made but slow progress in this country. Even the coming of the Normans did not much accelerate matters. They were, indeed, a far more civilized race—so far, at least, as refinement went—than the Anglo-Saxons or English, but the Norman King, or baron, was as content that the window openings of his stone castle should be mere unglazed holes as was the Saxon thegu that similar apertures in his wooden manor-house or grange should be equally undefended. It is, hence, needless to say that glass vessels, bottles, goblets, &c., were unknown to all classes. It seems probable that here again the Church led the way by having her sacramental chalices for communion formed of glass when the Church could not obtain those of the precious metals.

Glass windows in this country were, indeed, a luxury which did not come at all into use for private dwellings until a much later period than that in which they had become tolerably common in more cultured lands, such as Italy and France. It was from the latter country that we derived the colours, well on in the Middle Ages. At first all our glass was imported, then a glass-house was established in England in 1557, "in the place called Crutched Friars, in London." Soon after we find that excellent white flint glass, little inferior to Venetian, was made at Savoy House, in the Strand. In *circâ* 1670, at a glass-house in Lambeth, under the patronage of the Duke of Buckingham, particularly excellent glass was manufactured.

It is not known who first conceived the notion of turning transparent glass windows into coloured pictures. The earliest practitioners probably drew the mere outline.



DESIGN FOR PAINTED AND ENAMELLED WINDOW.

"The chapel of Our Lady at Warwick," observes Mr. R. Mathews, in the *Illustrated Carpenter and Builder*, "was ornamented anew by Robert Dudley, Earl of Leicester, and his

countess, and the glass painter's name still remains on the window, with the date, 1574, and in some of the chapels at Oxford the art again appeared, dating itself in 1622, by the hand of no contemptible master. Many dates could be supplied in the gap of forty-eight years on Flemish glass, but nobody ever supposed that the secret was lost so early as the reign of James I., and that it has not perished since will be evident by the following series, reaching to the present hour. There are twelve windows, dated 1518, in the library at All Souls, Oxford, in the chapel of Queen's College.

"In a chapel at Warwick a cipher P. C., 1574, can be seen on the painted glass. The windows at Wadham College, the drawing of which is very good, with fine colours, are by Bernard Van Linge, 1622. In the chapel at Lincoln's Inn a window, with the name Bernard, 1623, is probably the preceding Van Linge. In the church of St. Leonard's, Shoreditch, are two windows by Baptista Sutton, 1643. There are several windows to give testimony to the fact that our predecessors were no mean artificers. It would not be unwelcome to the curious reader to read some anecdotes of the revival of taste for painted glass in England. Price was the only painter for many years in his own particular style in England. Afterwards one Rowell, a plumber at Reading, did glass work, particularly for the Earl of Pembroke; but Rowell's colours soon vanished. At last he found out a very durable and beautiful red, but he died in a year or two and the secret with him. A man at Birmingham began the same art, and fitted up a window for Lord Lyttleton in the church at Hagley. After this one Peckit began the same business, and attained great proficiency. A few lovers of art collected some panes from ancient buildings, particularly Lord Cobham, who erected a 'Gothic temple' at Stowe, and fitted it with the arms of the old nobility, &c. A glazier named Palmer, of St. Martin's-lane, bought glass which came from Flanders, and fitted up entire windows with mosaics of glass of different colours. Painted glass from Flanders was sold by auction in the Strand, consisting of Flemish coats-of-arms, birds, and flowers in colours, and Scripture stories in tracing black and and stain. Oliver Cromwell, in his time, made great havoc in the churches, the idea of his people being to destroy everything associated with the opposite religion. . . . Some old windows that now remain had to be buried to save them, and some can now be seen in the colleges of Cambridge that have been dug up and restored. The design accompanying this chapter

represents an enamelled window, the date of which is not known, but which must be very old. The colouring of the background was pink and blue, the ornament being in yellow stain and white. The diamonds surrounding it were white sheet. This beautiful remnant of antiquity was totally destroyed in the reparation of the windows in 1793, and formed the east windows of the chancel of Petistree Church. By following the history of glass it will be seen that wonderful improvements have been made in its manufacture. The progress was slow in the first place, but in the last few centuries stained glass became very popular and much more developed, and not so conventional as in the first stages of the art.

"The modern style, which is altogether different, represents the real more than the ideal, and English art was also developing, subject windows being produced of much artistic merit. The simple cross hatching gave place to flat shading, the figures were larger, more anatomically correct in drawing, and well painted. The harsh, garish colours were abandoned, and the various tints of glass selected with due regard to light and shade; in fact, the productions of the period might correctly be called fine art work.

"There are many fine examples of fourteenth century work still extant, and readers who wish to see specimens may find them in Merton College Chapel, Oxford; in Bristol, Gloucester, and Wells Cathedrals, and the ancient church at Tewkesbury. That in Merton Chapel has the date 1283 assigned to it, but if 100 years were added, we fancy we should be nearer the true date, as there are many details in the work to prove it of the latter half of the fourteenth century. It was reserved for the fifteenth century—that golden epoch of all arts—to produce the grand windows that we all so much admire. It was just the period when all art work appears to have reached the zenith of perfection. That was the time when the old masters painted their masterpieces; the great architects wrought living monuments in stone; the armourer, having achieved perfect protection to his patron, brought his war gear to its greatest perfection of shape and ornamentation; the latten maker engraved his finest monumental brasses; the costumier brought the art of dressing to an embarrassing stage of costly extravagance and enrichment; and the glass painter produced his glories in glass.

"The earliest practitioners probably drew the mere outlines of the figures and used a little stain. Painting on glass appears to have been first practised by the Byzantine Greeks, and from

Byzantium to have found its way westward to Venice and Rome, and from thence to Marseilles. The earliest coloured windows of which there is any record were those in St. Sophia at Constantinople and those of the basilicas of St. John Lateran and St. Peter at Rome were adorned about the same time and in almost the same style. This was as early as the sixth century. There is still in existence, at the Vatican, the record of a window ordered in the eighth century. It is signed by Pope Leo and dated A.D. 795, a period when England was overrun by barbarians. Probably the oldest coloured glass windows in existence are those to be seen in the monastery of Tegernsee, in Bavaria. They are simply crudely-coloured pieces of glass, held together by strips of lead, and were made in the latter half of the tenth century. There are but few records of painted glass till the twelfth century, when we find that it was produced in some quantity by several artists in the South of France. The Germans also at this period had a good knowledge of this purely ecclesiastical work. The art was practised solely by members of the religious bodies. In England, during the twelfth century, the making of windows for churches appears to have been in a very elementary stage, as it simply consisted of leading together pieces of colour glass so as to form mosaic patterns of garish colouring. Of this style of work there are in existence a few specimens, but they are very rare and show merely the germs of any artistic merit.

"The thirteenth century witnessed a great change in English art. Painted figures, foliage, and ornament were now introduced; but they were simply outlines in deep brown colour, with sparing attempts at shading in cross hatched lines. The drawing was very crude and conventional, and the execution also very faulty. Of this period many samples exist, the best, perhaps, being in York Minster, Lincoln, Salisbury, and Canterbury Cathedrals. The design usually consisted of pictorial medallions placed on a geometrical or foliated background with broad borders. The colouring was still crude, consisting principally of red, white, and blue glass, but the individual pieces were selected with some degree of skill and the whole work is not at all inharmonious. Pains were taken chiefly with the heads, hands, and feet of the figures, which were outlined in a characteristic manner, and the colour was afterwards burned in. It must be remembered that in those days brushes were unknown, and most of the outlines were put in with finely-pointed feathers—certain little feathers from the wings of the

woodcock being held in great esteem by the monkish glass painters. Neither had these early artists the help of glaziers' diamonds to cut their glass: every piece had to be cast, and then "grosed" or chipped to its exact size and shape by means of implements called "grosing irons," which were blades of iron having square notches of various sizes along the edges in the manner of the wards cut in keys. Glaziers' diamonds came into use during the reign of Queen Elizabeth.

"The fourteenth century wrought wonderful changes in the art, especially in Italy, where there was a recognised school of glass painting, which existed for upwards of a century. Many beautiful examples of this Italian work being still in existence, we are enabled to note the actual progress the art made during the period. The drawing, colouring, and painting seem to have increased in beauty with each decade of the fourteenth century both in Germany and Italy, and it would be difficult to say which of those countries bore off the palm."

The following remarks on "Stained Glass," by Mr. Somers Clarke (prefixed to the catalogue of the Arts and Crafts Exhibition for 1888) are so germane to our subject that we think it well to reproduce them :—

"In a collection of craftsmanship, such as that now brought together, a specimen of stained glass must not be judged from the standpoint of the mere archæologist. The art had languished during the seventeenth and eighteenth centuries, and began to lift its head only with the revived study of the architecture of the Middle Ages. To attain archæological correctness was one of the chief aims of the revivalists. The crude draughtsmanship of the ancient craftsman was imitated, but the result lacked the spirit and charm of the original. Under such conditions the modern worker in stained glass has produced things possibly more hideous than the world ever saw before.

"Departing altogether from the traditions of the Mediæval school, there has arisen another school which has found its chief exponents at Munich, and has produced transparencies no better than painted blinds.

"What, then, it may be asked, are the limiting conditions imposed upon him by the nature of the material within which the craftsman must work to produce a satisfactory result?

"In the first place, a stained window is not an easel picture. It does not stand within a frame, it is not an object to be looked at by itself, but must play its part in the adornment of the building in which it is placed, being subordinated to the effect the

interior is intended to produce as a whole. It is, in fact, but one of the many parts that go to *produce a complete result.* A visit to one of our Mediæval churches, such as York Minster, Gloucester Cathedral, or Malvern Priory Church, each of which retain much of their ancient glass, and a comparison of the unity of effect there experienced with the internecine struggle exhibited in most buildings furnished by the glass painters of to-day, will surely convince the most indifferent that there is yet much to be learnt.

"Secondly, the great difference between coloured glass and painted glass must be kept in view. *Coloured glass* is obtained by a mixture of metallic oxides whilst in a state of fusion. This colouring pervades the substance of the glass and becomes incorporated with it." It is termed "pot metal." "To *paint* glass the artist uses a plate of translucent glass, and applies the design and colouring with vitrifiable colours. These colours—true enamels—are the product of metallic oxides combined with vitreous compounds, called fluxes. Through the medium of these, assisted by a strong heat, the colouring matters are fixed upon the plate of glass."*

"In the window made of coloured glass we have the material itself dyed with the richest tints in its full substance, the different pieces being held together by lead lines, and forming a species of translucent mosaic. Some details are painted and burnt on, but the main effect of the work is obtained by the rich colours of the pot metal itself contrasted with the pearly tones of the clear glass. In the painted window translucency is nearly lost. Shadows are obtained by loading with enamel colours, and at the best the painted window becomes an indifferent picture, badly painted.

"In the painted window the lead lines, without which the various pieces of glass cannot be held together, are, as far as possible, concealed. In the stained window the craftsman makes them his servant, and uses them as a means of giving additional richness of effect. They form an integral part of the design."

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* "Industrial Arts—Historical Sketches," page 195. Published for the Committee of Council on Education. (Chapman and Hall.)

CHAPTER II.

THE MANUFACTURE OF GLASS.

"THE materials principally used in the manufacture of glass are sand, with an alkaline substance, either a salt of soda and potash, or lime. though in some kinds of glass oxide of lead takes the place of lime. Other materials are generally employed to correct impurities which may occur in the sand, and which, if present, always impart an objectionable colour to the glass."

So says Professor Barff, M.A., and he goes on to remark :—

"There are two kinds of glass in ordinary use—common window glass, which may be divided into sheet, crown, and plate ; and flint glass, which is used for decanters, wine glasses, and tumblers, and in some special forms for ornamental stones in imitation of jewels, and also for lenses of telescopes and microscopes. The materials for making these different kinds vary somewhat, although the principal constituents are the same—viz., sand, with some salt of soda or potash." *

In the manufacture the carefully selected materials are mixed and placed in the furnace, where they are heated for some time, a process which is known technically as "fritting," and which has for its object to perfectly dry the materials. When this operation is completed the frit is placed in a hot "glass pot" and exposed to the full heat of the furnace until the ingredients amalgamate and constitute glass. The glass pots are formed of Stourbridge fireclay.

M. Gehlen, an expert, gives the following formula for ingredients of a good window glass : Sand, 100 parts ; sulphate of soda, fifty parts ; quicklime, twenty parts ; carbon (as charcoal), two parts. Different makers employ other mixtures, and the above proportions may be received as approximate.

"In the making of common window glass," observes Professor

* "British Manufacturing Industries: Glass and Silicates." By Professor Barff, M.A. (Stanford, 1877.)

Barff, "ordinary sand, which does not contain any large quantity of iron, may be used, the alkali employed being sulphate of soda while the purifying material is either arsenic or black oxide of manganese. A small quantity of anthracite coal is added to the mixture in order to assist in the reduction of the sulphate of soda, together with some lime. The materials are carefully mixed and placed in the furnace, where they are heated for some time, a process which is called 'fritting.' Its object is to perfectly dry the materials, so as to expel carbonic acid gas, which would otherwise cause swelling in the glass; but no combination must take place to allow of silicates being formed, otherwise the alkali would melt first and attack the substance of the glass pots, and part of it would be volatilized and lost. When this operation is completed the 'frit' is put into the hot glass pot and submitted to the action of the furnace."

Seeing that all window glass, as we see and use it, is perfectly flat, it seems strange that in its molten condition it was first "blown" somewhat after the method whereby a child blows soap bubbles. Yet so it is.

For "sheet glass," formerly called "broad glass," the workman gathers a portion of molten glass at the end of his long iron "blowpipe." This he blows into a pear-shaped sphere. This is so manipulated that it becomes a cylinder, which is next slit open with a diamond, and, being placed on a flat surface whilst still plastic, opens out into a flat sheet. A sheet-glass blower requires to be a very robust man, for the cylinders which he blows are frequently 60in. long, and their weight is very considerable; much dexterity and skill is also needed.

In blowing crown glass the glass bulb blown by the operator has a perforation formed in its end. The workman holds this open end before an intensely hot furnace, meanwhile rotating the glass on his "pointel" (or rod) until, with a startling suddenness, the bulb of hot glass flies open and assumes the form of a circular plate.

This operation is performed opposite to what is termed a "flashing furnace," which is heated to such an intense degree that only workmen inured to it can sustain the high temperature, and even these have their faces and chests protected by a shield. The circular plate of glass is subsequently separated from the rod, the place of their junction forming a boss in the centre of the circular sheet, which the workmen know as the "bull's eye." The sheet of glass is afterwards annealed in a special furnace.

The manufacture of plate glass is differently conducted. The molten glass is emptied on a level iron table of the dimensions sufficient for a large plate. On the raised borders, or margins, of this table the gudgeons or journal-ends of a smooth iron roller run. The contents of the glass-pot when emptied upon this table are in a plastic state, not in an entirely fluid one, and yield like putty or dough to the action of the heavy cylinder as it is rolled up the table. These plates are afterwards annealed and ground smooth and finally polished.

For decorative glazing both glass coloured in the manufacture is used and the glass hand-painted and afterwards "fired" or "kilned." As for the colouring of the glass material in the process of manufacture, gold (observes the *Pottery Gazette*) is employed to impart to glass a beautiful ruby colour. Sub-oxide of copper gives a red colour. Silver, in all states of oxidation, gives a variety of beautiful yellow and orange shades to glass. Antimony, lead, and silver, in combination, are employed to produce the inferior yellow colour. The oxides of iron give the glass various shades of green, yellow, red, and black. Oxide of chromium gives a fine green, and oxide of cobalt a splendid blue. The colour most valued, next to that produced by gold, is the yellow communicated by oxide of uranium, which has an appearance resembling shot-silk. White glass, or enamel, is made by adding either arsenic or the oxide of tin to the melted metal.

CHAPTER III.

GLASS CUTTERS AND GLASS CUTTING.

It is needless to say that from the very initiation of the use of glass for glazing windows, it has been necessary to fashion

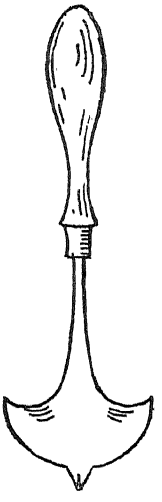

Fig. 1.

pieces of the material to fit into the spaces for which they were intended. How was this effected? The utility of the diamond for cutting glass was not discovered until the period of the Renaissance, yet the Roman glaziers of Italy and Byzantium, and the Gothic church builders succeeded in bringing their glass into sizeable portions.

Two theories have been ventilated as to their probable method or methods.

Some hold that the early glass-makers poured their material in a molten state into moulds and moulded each piece separately. Others are of opinion that the glass was made in larger pieces and cut by drawing a red-hot iron or copper point along where the line of division was required to be. This would crack the glass along its course, so that the portion could be easily detached.

Of course, this latter procedure would leave the edges somewhat ragged or rough. This, doubtless, the Mediæval glazier neutralized by "grosing" them. This term may be considered as pretty well equivalent to the participle "nibbling." The operation was doubtless effected by the ancient glass-cutter with the aid of a "grosing iron." This was a small piece of iron with a series of gaps up the side in which the rough edges of the glass could be inserted, and minute portions thereof forcibly broken off.

Fig. 1 represents an old-fashioned manner of mounting the glazier's diamond. This is extracted from a very large, scarce, and magnificent work on all trades as carried on in France just previous to the great Revolution of the end of the eighteenth century.

The lower figure in fig. 2 shows the glazier's diamond of the present day. Here the handle, D, is terminated by a ferrule, B, to which the steel "block," A, is swivelled in such sort that it will turn. The end of the block is bevelled, and in the centre of the oblique end the "spark," or diamond, B, is fixed. The upper figure in this illustration shows a modern diamond with "gaps" in the block, which are very handy for "grosing." The centre figure is a glazier's T-square, marked with inches divided into one-eighths. These can be had of 18in., 24in., 30in., or 36in., as desired. The glass-cutter also requires one or more glazier's laths, made of stout boxwood, 1¼in. wide and brass-tipped. These are made in lengths of 24in., 30in., 36in., 48in., 60in., and 72in.

Fig. 3 represents a knife diamond in which the diamond is hinged into the handle. This is a very convenient form.

Some "knack," which can only be gained by experience and practice, is required for manipulating the diamond in glass-cutting. It is held in the position shown at fig. 4, and the operator has to "humour" it until he finds the cutting edge.

Fig. 5 shows two forms of the American glass-cutter, now

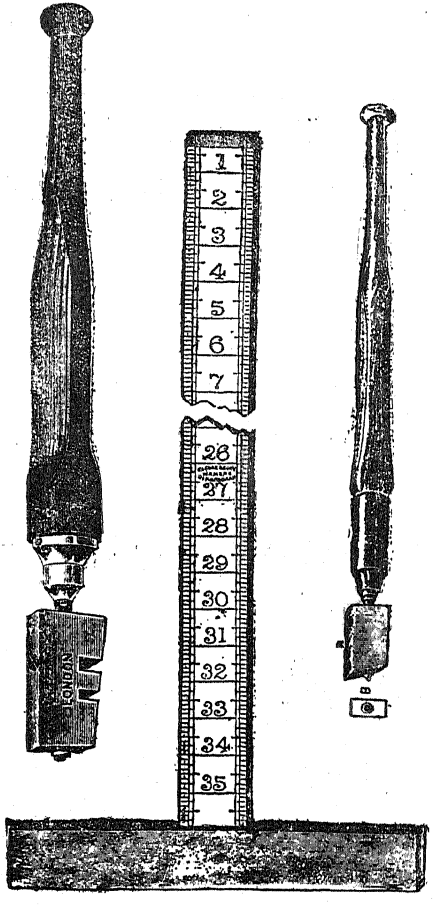

FIG. .

sometimes used as a substitute for the diamond. Its cutting agent is a small, hardened steel wheel, as shown.

The straightedge, T-square (fig. 2), and compasses are all

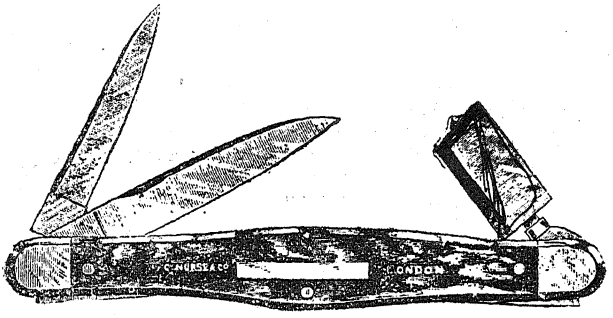

FIG. 3.

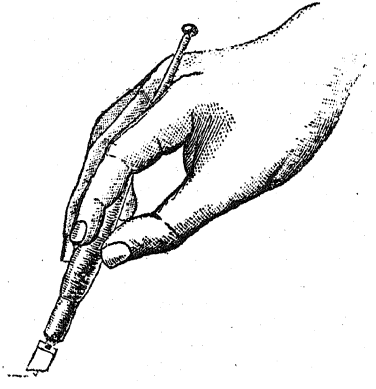

FIG. 4.

necessary adjuncts in cutting up glass. Figs. 6 and 7 show two ways of cutting slips of equal width from a plate of glass. A simple contrivance like fig. 7 enables the glazier to reduce his

slip of glass to quarries (derived from the French word "square"), whilst one resembling fig. 9 aids in the production of the small diamond-shaped frames used in leaded casements.

Circles of glass may be cut by the beam apparatus shown at fig 10, and also by the contrivance figured at figs. 11 and 12.

And here, at some risk of tautology, we will reproduce what we have written for a well-known journal.

The cutting tool of the glazier of to-day is the glazier's diamond. We have spoken of earlier and less efficient instruments used for this purpose in a former chapter, and in the one appropriated to tools have described the diamond. It only remains here to again emphasize the paramount importance of getting a good and reliable tool, and to speak briefly of the proper manner of using it.

In cutting, the implement is held in a slanting direction, as shown roughly at fig. 4. Diamond sparks will only cut at one angle, which must be found by trial. When held at the right angle the stone will cut a real, though shallow, channel in the glass. If held at any other the stone will only scratch. The ear ought to be able to judge by the sound made whether the right operation is being performed, for the creaky sound emitted by the diamond when only scratching is utterly unlike the smooth, equable sibilation yielded when it is cutting. If the glass does not readily sever when cut, a smart tap on the side opposite to that on which the incision was made will cause it to part. A couple of straightedges, one of a foot and the other of a yard in length, should be provided, and also an ordinary "set square" of an angle of forty-five degrees. It must be borne in mind that in a properly made diamond the cutting point of the spark is 1-16in. from the edge of the block, and this distance has to be allowed for in cutting with a straightedge or any other kind of movable gauge.

We will first suppose the glazier desires to cut up a sheet of glass into quarries all of one size, and that these are rectangles of 4in. by 3in. We have, then, first to cut up the glass into strips of 4in. wide, which strips are known technically as "ranges." First lay your sheet of glass down flat on a layer of baize on the shop board. Then, by the aid of the straightedge, cut off a narrow slip from the edge, to secure that the edge is even. Next place your straightedge accurately at 4 1-16in. from the true edge which you have obtained by cutting off the strip, and, holding it firmly in that position, draw the diamond carefully along it, when you ought to have severed a "range" 4in.

wide, and the full length that the sheet of glass will allow. The 1-16in. allowed over the 4in. is made for the distance of the cutting point of the diamond from the edge of the block or mount.

The "gauge" can, of course, be taken with a pair of com-

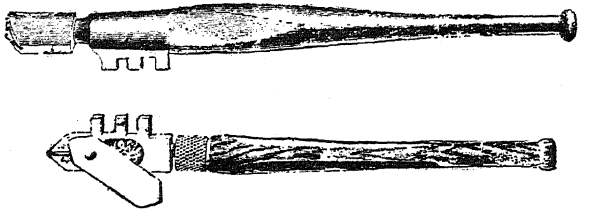

FIG. 5.

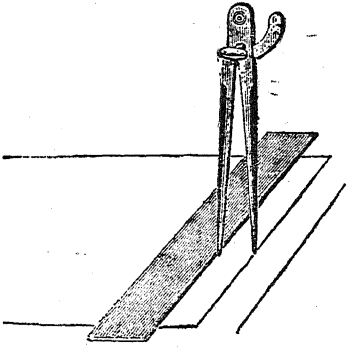

FIG. 6.

passes (fig. 6). The operation of cutting up a sheet of glass into "ranges" may be accomplished most speedily by making a gauge, by the aid of which the straightedge is more readily got into position. This may be done by cutting away part of the edge of a strip of deal for the length desired for the "range," and 1-16in. added, which is used by placing it against

the sheet of glass, and adjusting the straightedge to it as at fig. 7. By the aid of this simple adjunct the glass can be cut into slips very quickly indeed.

We have now to divide the range into separate quarries, whether rectangular or lozenge shaped. This can be best accomplished by a simple "gauge-block" or "gauge-board,"

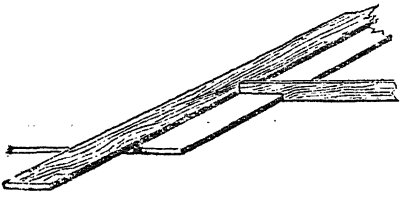

FIG. 7.

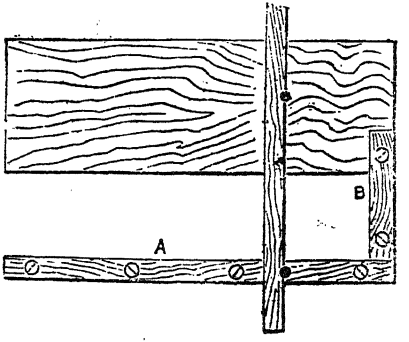

FIG. 8.

somewhat after the pattern of that shown at fig. 8, which any joiner can readily construct or the glazier can make for himself with a few pieces of deal. It has a raised edge, A, running along the front or edge nearest to the operator. If for square quarries, the slip, B, is screwed or nailed on at right angles to A, while the strength lath, C, butts against two nails driven one into the wooden bottom, and the other in the front edge, as shown

by the black dots, both at the distance of the breadth of the quarry plus 1-16in. from the lath, B. The "range" or slip of glass is pushed up to B, then C is adjusted to the nails, and the diamond drawn across the glass. This is also a process which can be very rapidly conducted.

Fig. 5 shows the glazier's diamond to a larger scale. Here A shows the steel "block," the end of which is slightly oblique.

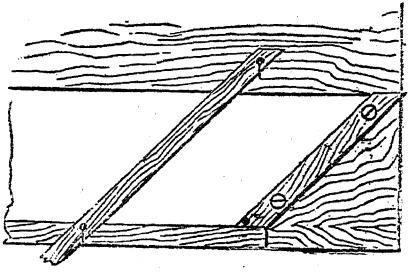

FIG. 9.

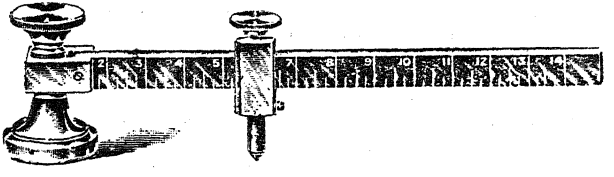

FIG. 10.

In the centre of the slanting end of this the "spark," B, is fixed. C is the ferrule which connects the block with the handle, D, the latter being so shaped as to allow of firm hold by the fingers.

When the quarries are to be lozenge-shaped or of any other form bounded by right (straight) lines, it is, of course, easy enough for anyone to construct a practical gauge-board. At fig. 8 one adapted for lozenges is shown in plan. Here, of course, the two gauging-laths, B and C, run at an angle of forty-five degrees with the elevated edge, A.

Some stained glass glaziers have a "glazing board" for cutting out instead of laying the cut line on the ordinary shopboard. A portion of a "glazing board" of useful form is shown at fig. 14. It is composed of sound planed pine boards, glued, or grooved and tongued at their edges, with a raised edge, A B, to the side and top. These edges are fixed on by screws so as to be movable. Two of the edges of the cartoon can be slipped under these, and the paper secured in place by simply tightening the screws.

The other method of cutting out is to cut up the cut line into separate portions, and use each of the pieces of paper so obtained as a "template," or pattern, by which the diamond may be guided.

It may be here observed that when a slight channel has been cut on the face of a piece of glass by the diamond, separation is more readily effected by giving the glass a slight tap on the back or the side opposite to that on which the cut was made.

It now only remains to allude to the shaping of pieces of glass to at least some degree by the operation which is known in the trade as "grosing," or "groozing."

This operation is only of slight use at the present day, but there is but little doubt that the ecclesiastical glaziers of the Middle Ages resorted to it very much. That was in consequence of their very defective means for glass cutting. They had no glazier's diamond, and had to get their pieces of glass, at least rudely, to the desired shape by one of two processes—*i.e.*, either by casting the molten glass in a mould to the proper shape and size, or cutting it out of a large sheet by passing the point of a red-hot iron rod along the line where they wished the glass to divide.

The pieces thus roughly obtained were then brought to the exact shape mainly by grosing.

It is a singular fact that this word "grosing" (like a great many other technical words employed by operative craftsmen) is a perfectly insoluble puzzle to philologists and other learned men. For there does not appear to be any reasonable cause for the existence of such a queer word as "grosing," or "groozing," or how we came by it. Neither have we any other word of at all similar spelling or sound in English which would throw any light upon it. However, the word "grose" clearly signifies to "bite" or "nibble," and that term just correctly describes the operation, which is effected in the following manner :—

Let us suppose it is required to remove a small curved

or even angular portion from the side of a certain piece of glass, and it is doubtful whether it would be safe to make a cut far enough in and break the piece out. Say, a semi-

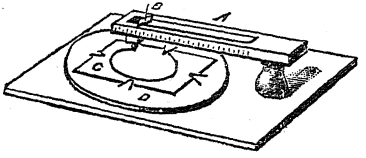

FIG. 11.

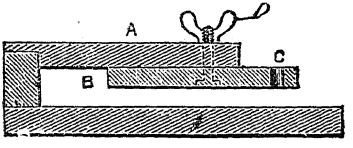

FIG. 12.

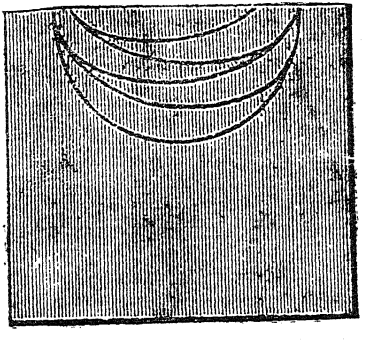

FIG. 13.

circular piece of red glass. Then, first with our diamond we make a series of concave segmental cuts, as shown at B, and with a pair of pliers we break, or "nibble," away the pieces of

glass, as shown at B (fig. 13). If the glazier has no pliers handy, the notches in the sides of an American glass-cutter would answer the purpose, or even one of the slots in an ordinary house key. French glaziers used to employ (and, we believe, still do use) a tool termed a "groseuir" or "egroseuir," with slots in the side to take hold of the glass with. It is very probable that our word "grosing" comes somehow from the original Norman-French term for a Mediæval "groseuir," something like the French one which the monkish glaziers may have introduced from France soon after the Norman Conquest.

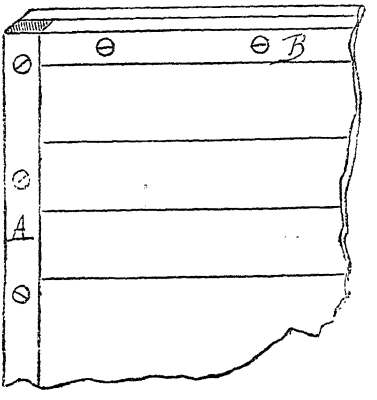

FIG. 14.

Circles, semi-circles, and other curvilinear forms require more careful management to produce them correctly and expeditiously. A small machine (called a "circle-table") for glass cutting can be obtained of many vendors of glaziers' tools. One form is shown at fig. 11. This is very useful, but somewhat expensive.

An economical substitute for this may, however, be rigged up by the glazier as at fig. 12. This, as will be seen, consists of a slotted piece of hardwood, A, secured by a thumbscrew through the slot to the upright, B. At the other end of the arm, A, is a perforation, C, through which the diamond can be

inserted at the proper angle to cut. It is obvious that, by setting the slotted radial arm at any distance desired by the thumbscrew, D, semi-circles and other curves of any size may be readily and accurately described or cut. This simple apparatus would not, however, be effectual for cutting out complete circles, but a modification of it capable of doing so may be easily constructed, and of wood. Other handy devices of a useful character may be readily devised and rigged up by the ingenious glass cutter.

Of course, for many purposes, "templates," or patterns, of

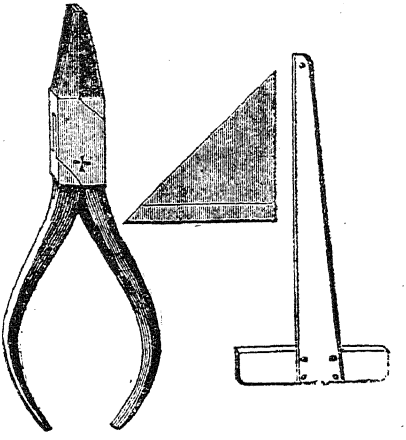

FIG. 15.

thin cardboard or zinc are very useful to guide the diamond. Equally of course, in cutting out the various pieces of different-coloured glass for an elaborate stained glass window, none of the preceding methods are adopted. One of two plans is usually resorted to. The more usual plan is to lay the cut line down on the level shopboard, place pieces of the various-coloured glass on it, and cut out the bits needed from each, taking care, in carrying the diamond along the lines of leading, to make allowance for the thickness of the calme.

Considerable judgment is required to select suitable material in glass cutting. We mean by that, in choosing from your glass in stock such pieces of each colour as will yield a pleasing variety of tones or shades when the light is glazed. This is a matter to be learned by experience and observation. In backgrounds especially the glazier should be careful to secure nice

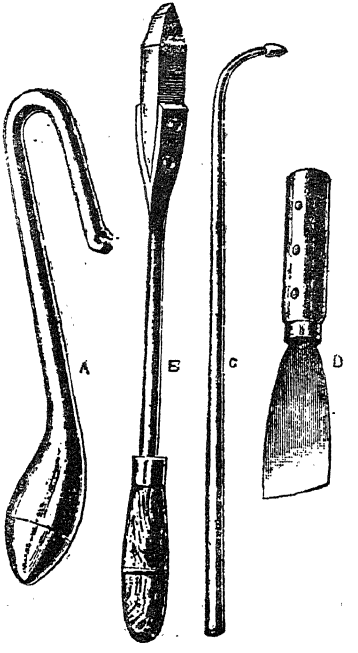

FIG. 16

shades of colour so as to produce a restful and harmonious effect to the eye.

Some glass is so dark that the outline cannot be seen through it for cutting. In such cases we can resort to "pouncing." This

is accomplished by tying up a little finely-powdered whiting in a bit of muslin so as to make a kind of "dabber." Then, suppose we have to cut a bit out of a piece of very dark glass, we breathe on the glass, so as to cause a slight humidity on its

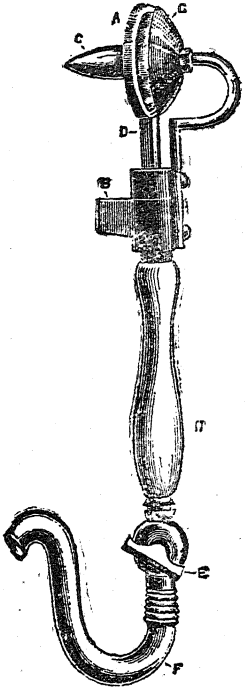

FIG. 17.

surface, and then dab it over with the pounce-bag. This then causes a very slight coat of the whiting to adhere to the glass. The outline is next laid on it, and the lead line around the space

which the piece of glass is to fill is then to be traced around with a steel or agate style, a H.B. or F. lead pencil, or even a sharp-pointed piece of hardwood. This will cause the whiting to leave the glass wherever it passes, and adhere to the under side of the outline. It will be easy enough now to cut out the glass by the lines where the whiting is removed and the dark glass exposed.

It seems convenient in concluding this chapter to speak of the other tools required by the glazier.

For ordinary sash glazing he employs a "hacking-knife" for removing old putty, glass, &c., a "putty-knife" for manipulating the fresh putty, a pair of pliers (fig. 15 A), a set square or two (B in same figure), and a T-square, already described (C, fig. 15).

The glazier requires a cutting knife to cut off his calmes, trim them, &c. This is made of various forms, and frequently consists of a short, stout blade set by the glazier himself in a leaden handle. The soldering-iron is an indispensable adjunct in fretwork glazing. The usual form was the ordinary bulbous-ended iron shown at A, fig. 16. Others used the square copper "bit" or bolt employed by the whitesmith and the gasfitter (B, fig. 16). Both are now rapidly becoming obsolete for glazing, in consequence of the superior adaptability of the gas soldering-iron, of which fig. 16 represents a self-working soldering-bit, well adapted for fret-lead work.

Fig. 17 represents the most improved form of gas soldering-iron. Here the flexible pipe, F, is provided with a hollow handle, H, by which the tool can be easily moved about. From this the gas passes along the pipe, D, to the heating apparatus, A G, which keeps the "bit," C, at the proper temperature. This is a most useful appliance, of which there are several forms. In this a vertical copper bit is kept at the right temperature for fusing the solder by a ring of small gas jets, the whole being capable of being moved about by the operator over the surface of his light wherever the joints are required, in consequence of the gas soldering-iron being connected with the nearest gas burner by a flexible tube.

CHAPTER IV.

DESIGNING FOR STAINED GLASS.

THE first step in the production of a window in stained and painted glass is obviously to make a correctly-drawn and accu-

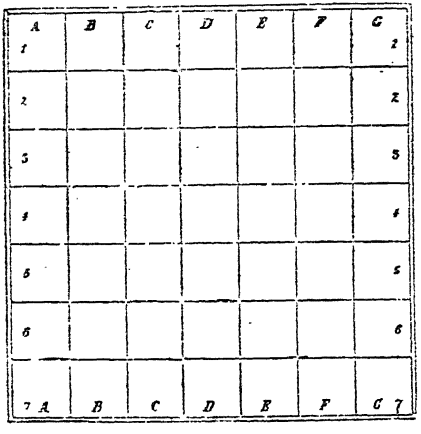

FIG. 1.

rately-coloured design of the window on a small scale. This observation is more particularly applicable to windows to be filled with figure-subjects, "geometrical" designs being of inferior consequence. Of course, none but a professional artist (and one of high class) can execute work of this description, a fact which accounts for the number of inferior windows we find in the least likely places. It is obvious that the stained glass

artist is handicapped by conditions of which the ordinary painter in oil and water-colour knows nothing. The picture of the former is seen by "transmitted" light (*i.e.*, by light which passes through the picture), while that of the latter is seen by reflected light. Thus during all its stages the ordinary painter can touch up, obliterate, "scumble," or "glaze" portions of his picture until he gains relative perfection, opportunities denied to the designer for glass.

The production of a design, as described in the immediately preceding chapter, is, of course, a work demanding some inventive fancy and a not inconsiderable degree of artistic skill. But, given a design made to whatever scale, the production therefrom of a "cartoon," or drawing of the full size of the window required, in black and white, is a mere matter of mechanical routine, to which any artisan who can draw at all should be adequate.

Doubtless in many, if not most, cases the original artist who executes the design produces also the cartoon from it; but whenever necessary the glazier himself ought to be competent to do this. The "cartoon" (a word formed from the Latin term for paper) is simply a full-sized paper drawing produced from the original, designed generally by the process technically known as "squaring off," and intended to form the basis of the "cutline," or actual "working drawing" of the shop.

For small "cartoons" ordinary good cartridge paper can be used. For larger ones the "continuous cartridge paper" made for engineering and architectural drawings should be obtained. It is 54in. and 60in. in width, made in a roll, like present-day printing paper, and is sold by the yard. It runs from about 5d. to 10d. per yard, and can be obtained of most good stationers.

The cartoon can be executed in either charcoal, black french chalk, or sepia, according to choice, the last being most suitable for certain kinds of work. Vine charcoal, in sticks, can be obtained of any good artist's colourman at about 8d. per dozen sticks, and powdered charcoal, for rubbing in shadows with the stump, in boxes. Felt and leather stumps cost from 3d. to 6d. each; tracing paper, 2d. to 4d. per sheet; continuous ditto, 44in. wide, 8d. per yard run.

Operations are commenced by pinning down a piece of tracing paper over the design, and making a careful tracing with a sharp-pointed H.B. lead pencil. A boundary line is then ruled around this tracing, a pair of compasses are set to

say, ¼in. (⅛in. or ½in. would do, but ¼in. is generally most convenient), and the two horizontal and two vertical boundary lines "stepped" with the compasses, so as to leave a series of minute indentations or holes to guide the ruler in ruling lines both across and up and down, in such sort that the whole surface of the tracing is covered with a series of ¼in. squares. It is well, next, for greater facility, to number the squares on the outside of the marginal line on each side, running from top to bottom, 1 1, 2 2, 3 3, &c., and letter the top squares above the margin from left to right (A, B, C, D, fig. 1). The tracing is then ready.

The cartridge paper for the cartoon is now stretched on the drawing-board, or other smooth surface of wood, for "sizing."

"Sizing" consists in washing over the paper with a slightly adhesive solution, used by paperhangers and others, and known as "paper size," to the end that the charcoal drawing to be made upon such paper be caused to adhere more firmly to its surface, so that it shall not be so readily rubbed off. This size consists of water in which cuttings of vellum or parchment have been boiled. It is used hot, spreads easily, and is colourless. To make paper size, procure some cuttings of vellum, forril, or parchment. These are the trimmings off skins of these substances, and can be purchased cheaply (about 8d. per lb.) of most vellum binders and wholesale law stationers.

Cut these up with the scissors into pieces about ⅛in. square, place them in a clean glazed earthenware pipkin, fill up with water, put something in the shape of a lid over to keep out soot, dust, and blacks, set on the fire, and let simmer for some time. Strain or pour off the solution from the cuttings. When set aside and permitted to get cold, the size should be a clear quaking jelly. If not consistent enough, add more cuttings and re-boil; if too thick, add water and do the same.

"Jellied" size for paperhangers, whitewashers, &c., can be bought at most oilshops, and is sometimes used as paper size. But as this is made from boiled up glue, it is not so colourless as vellum or parchment size, which latter is, therefore, preferable. The size, used warm, is to be applied equably to the cartridge paper with a soft-haired brush, taking care neither to miss any part of the surface nor, if possible, to go over any part twice, as, if the size be laid on thick and streaky at places, the drawing will not be so good.

The sized paper is now to be permitted to dry gradually, without being exposed to artificial heat. When perfectly dry,

FIG. 2.

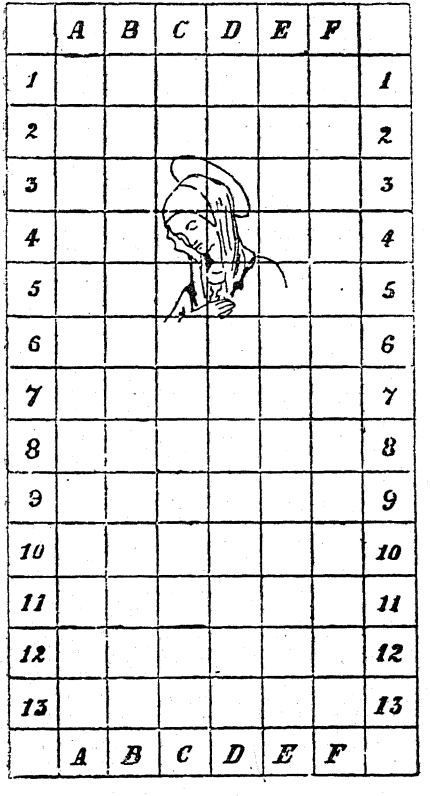

FIG. 3.

it is ready for "squaring off." Now we squared our tracing in ¼in. squares, and we have first to decide what enlargement of scale is necessary to obtain an enlargement of the full size of our window. We will suppose the latter is to be 7ft. in height by 2ft. in width, and is what is termed "a figure" subject. Say, for example, it is a memorial window to a deceased younglady named "Mary," and that we wish to appropriate the standing figure of Madonna from Fra Filippo Lippi's picture of the Annunciation, now in the Old Pinakothek, at Munich (fig. 2). Well, deciding that we are working on the "inch scale," where the ¼in. of the original design becomes 1in. in the actual window, the ¼in of our tracing will become 2in. in our cartoon. Therefore we first carefully mark off on our cartridge paper in bold pencil lines an upright parallelogram, and mark the sides and top and bottom off in 2in. spaces, afterwards ruling lines from one to the other, so as to cover the paper with large squares precisely as the tracing was covered with small ones. Then we figure and letter the margin of the cartoon as on the tracing (fig. 3). Of course, the reader will see that in our diagrams of figs. 2 and 3 both the parallelograms are of the same size. This is because we cannot afford space for showing fig. 3 on a much larger scale. But, as we cannot do this, the plan of showing both on one scale will still render our instructions clear to the reader.

The paper employed is of the kind known in the trade as "lining paper"—that is to say, that description of common white paper with which paperhangers first cover a rough wall before hanging it with a superior wallpaper—say a satin paper of some kind. This lining paper is made in rolls of twelve yards length, the same as paperhangings, is 22in. wide, and is sold very cheaply at any paperhanging warehouse. In drawing the cut line a piece of the lining paper of sufficient size is laid down smoothly upon a level bench. Upon this is spread a sheet of artists' "transfer paper," colour side downwards, and over these again is laid the cartoon, face upwards, and the three substances of paper are firmly secured to the bench or board by a few drawing-pins stuck in along the edges.

We may here mention that the "transfer paper" can be obtained, either red or black, at most artists' material warehouses, either prepared in water or in oil, at 4d. per sheet or thereabouts; but the glazier can make it for himself, of sufficiently good quality for his purpose, more cheaply. By pinning down a sheet of ordinary "printing paper" (which can be got very cheaply of the wholesale stationers) to the board, and

scraping upon it an ordinary red or black crayon, and rubbing the same well into the paper with a stump, hare-foot, or bit of washleather, a sheet of very fair transfer paper may be made. Even common red ochre, well rubbed in, and the surplus carefully shaken off, makes a very good shift for comparatively rough work like transferring a glazier's cartoon.

The operation of transferring is performed by going carefully over the lines of the cartoon with a blunt point, bearing on it sufficiently hard to cause the red or black coat of the transfer paper to detach itself at such places, and adhere to the surface of the lining paper. The best implement for this purpose is an agate or steel stylus, such as is used by reporters in producing "manifold" copies. But any point, not too sharp, will do—as, for example, an H. lead pencil, or even a dogwood butcher's skewer, carefully pointed.

The glazier must exercise due discrimination as to which of the lines of the cartoon he requires to transfer. They are only those of the leading—that is to say, the boundary lines of the pieces of glass of different colours. The lines of the features of a figure subject, the shading of the robes, and such-like details, are, of course, not to be transferred; as they are simply matters for the glass-painter's care. The annexed diagram of a figure outline will exemplify our meaning (fig. 4). A good deal of tact and judgment are required in the workman who is preparing the cutline in the matter of always deciding discreetly exactly where the lead lines should run. If, indeed, he was also the designer of the window he has probably kept technical necessities in view whilst making the design. But if, as is very generally the case, the latter was executed by an artist, or even a professional glass-painter, it by no means follows that he will have done so, either in the original drawing or the cartoon, and the draughtsman who is transferring the cartoon to the cutline must make the necessary slight modifications.

These fall out in this way: The "flange," or outsailing wing of an ordinary calme projects usually about ⅛in. beyond the central stem, and, of course, covers the glass on each side. If this has not been properly allowed for by the designer, and in drawing the details of a hand or a foot, or hair or beard, he has carried the detail to the very edge of the piece of glass, the flange of the cartoon may lap over and hide some lines, with the effect that in the finished window a saint may lack the end joint of the finger or toe, or a corner of his beard, &c. For this reason, in tracing the cutline the operator should always

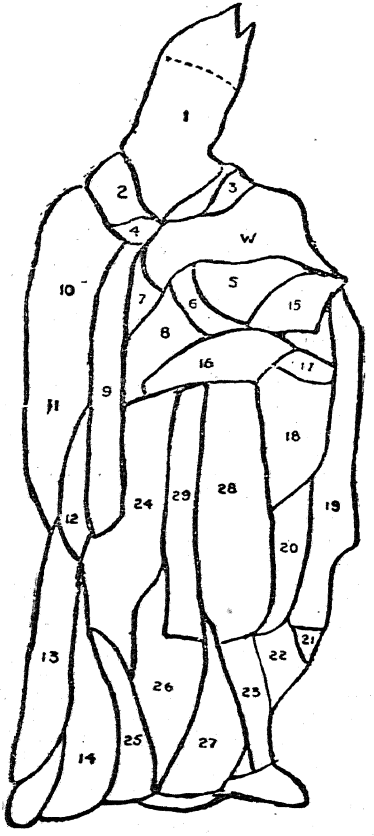
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FIG. 4.

mark his lead line ⅛in. outside such pieces. It is advisable to adopt the same practice with regard to any decorated or ornamented portions of the costume, as, for example, a diapered baldric, girdle, or orphreys of an ecclesiastical robe, and also for any architectural accessories, such as a canopy, baldacchino, or cornice over a figure or altar bases, capitals, tabernacled work, &c.

Now we are ready to commence the enlargement. Fasten up the tracing on the wall before you, and over the place where the board with the "squared" cartoon paper is placed. It is

FIG. 5.

very usual also to fix up near it the original coloured design protected by a sheet of glass.

With a stick of charcoal then commence to copy from the uppermost right-hand square of the tracing the portion of the design therein on to the topmost right-hand square of the cartridge paper. A reference to our diagrams (figs. 2 and 3) will render this clear. The first square occupied is 1 A, which contains a portion of the capital of the column above St. Mary's head. We only illustrate at figs. 2 and 3 the transferring and enlarging of the Blessed Virgin's head and shoulders. The

sketch of the cartoon at fig. 3 is only partially filled up; but enough is done to show the principle.

Only a very moderate skill in drawing, coupled with ordinary care, is required to accomplish "squaring off" most designs. The scale adopted at fig. 1 is smaller than that which we have recommended; but as these sketches are only explanatory of the process, that is of no material consequence. The charcoal will be found to be a fairly pleasant material to draw with, but now and then a part imperfectly burned may be come to which will not mark. Such can be scraped off with a penknife. Shadows in the draperies, &c., can be produced by sprinkling a little powdered charcoal at the place, and distributed or rubbed in with a "stamp," a bit of chamois leather, or even the end of the finger.

We have now to "fix" the cartoon. The sizing of the paper preparatory was done for this end. A charcoal drawing on ordinary paper could obviously be rubbed off and obliterated by the slightest friction; but by liquefying to some degree the size coat we can bind the charcoal atoms to the paper with some permanence. This is accomplished by the aid of steam as follows: A tin contrivance, known as a "vaporizer," which is not unlike a coffee-pot in form, but provided with a peculiar spout (fig. 5) is used for steaming or fixing the cartoon. This apparatus can be obtained of most artists' colourmen, and costs from 1s. to £1, according to size. Water is put into the pot and the spirit-lamp is lighted. When the water is brought to boiling-point, steam will be ejected freely from the peculiarly-shaped spout. The whole of the face of the cartoon is now to be exposed to this steam, taking care that no part is not steamed, and the result should be the fixing and securing to the paper of the charcoal drawing.

If chalk be used instead of charcoal as the drawing implement the cartridge paper will not require to be sized, but only marked off into the pencil square already described. The black chalk employed is generally the square French "Conté" crayons, which are made in three qualities, Nos. 1, 2, and 3, and sold at 6d. per dozen. No. 1, the hardest, is used for sketching the outlines and putting in smaller details. Nos. 2 and 3, being softer, serve to reinforce lines desired to look heavier and shadows. It is common to "outline" the design lightly with a lead pencil, and then go over the pencil lines with No. 1 crayon. The chalk is generally held in one end of a "port crayon," or chalk holder, and it should be borne in mind that to

sharpen the chalk to a fine point for delicate work it must be cut from the point carefully with a sharp knife. For producing shadows some chalk dust may be scraped on the paper, and rubbed in with a stamp.

Chalk is more permanent than charcoal, and is used on unsized paper; but, being used as a dry colour, it is still necessary to adopt some means of "fixing" it. This can be done by the use of a French chemical mixture known as "fixatif rouget," sold by artists' colourmen in bottles of various sizes from 1s. 6d. upwards. This preparation is blown over the surface of the chalk cartoon in a kind of fine spray by means of a "blowing flask," which can be bought at the same place as the fixative. By blowing into the tube of this the solution in the flask will be showered in spray over the drawing, and fix and protect it. It is best to fix up the cartoon on a wall, and, commencing at the top, spray it regularly downwards with the fixative.

The best method of making a cartoon is to execute it in sepia. Sepia is a kind of liquid indian ink, sold by the artists' colourmen in collapsible tubes at 1s. 6d., 3s., and 5s. 6d., according to size. This is, of course, virtually a paint, and is applied with a camel-hair pencil or cut sable brush. The design is to be first correctly made on the cartridge paper with a H.B. black-lead pencil. The lines are then gone over with the brush and colour. Too much care in making the pencil drawing cannot be taken, as obliterations, corrections, and alterations are exceedingly difficult to make in the sepia drawing. Sepia is, however, doubtless the best medium for cartoons, and where architectural accessories—such as pillars, arches, bases, canopies, baldacchini, or pavements—are represented, these parts are always put in in sepia, even in a chalk cartoon.

In many trades we find the principal person concerned—*i.e.*, he who conceives the idea, or, as we say, invents the thing, makes for himself (or has made for him by an expert from his own rough sketch) a carefully-made drawing (frequently coloured) of the church or house, the steam-engine or machine, which he proposes to construct; but such a drawing would be of little use to the artisans who are to build a house or make the machine—the mason or the carpenter, the smith, or turner, or fitter. They want larger, stronger, plainer sketches of the different parts which each class of workman has to make, and these we term "working drawings"—that is, drawings capable of being worked from. It is precisely the same with the lead-light glazier. The original prettily-coloured drawing, or even

the cartoon, would not at all answer his purpose, so another sketch, a working drawing, called technically a "cutline," or outline, is prepared from the cartoon, and shows exactly the "lines" by which the glass is to be "cut." This cutline is an exact representation of all the pieces of glass and the lead lines around them, which go to make up the finished window, everything in it being, of course, of the exact size required. Such a cutline can be prepared either on paper or on cloth—the latter being, of course, the more durable material.

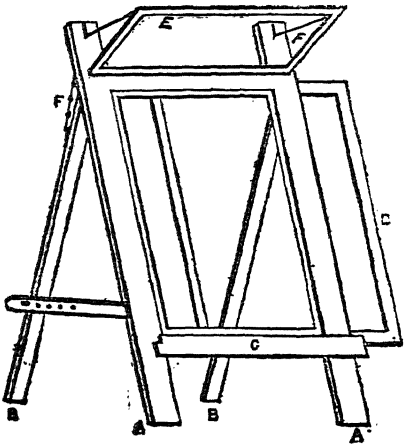


FIG. 6.

When the glass-cutter has cut out all his glass by the cutline, he hands in to the glass-painter those portions which it is necessary he should deal with. These are, of course, the faces (with hairs and beards), fingers and feet (if bare) of the figures, also any portions of the garments which require folds or shading put in, and any part of the robes or architectural or other background which need to be partly or wholly covered with a "diaper," or "repeat," pattern.

The glass-painter's implements are, in the main, similar to those used by other pictorial artists, and consist mainly of hair

pencils and brushes of various kinds. In addition to these he employs a table easel of somewhat peculiar construction, a perspective view of one form of which was given in fig. 6.

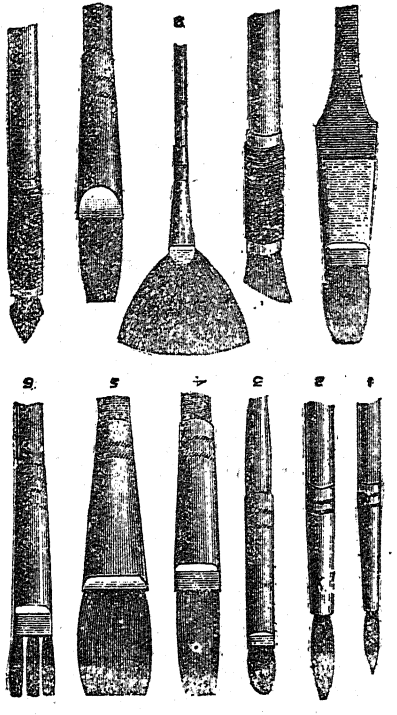


FIG. 7.

It will be seen from the illustration that this consists essentially of two rectangular frames, A A, B B (of pine or deal), so hinged together at the top that when their feet are drawn apart they easily stand steadily and firmly. The ordinary easel of the

painter has a single central back leg in most cases; but this would throw an objectionable shadow upon the glass painter's work, so his easel has a leg at each side instead. A sheet of stout white glass is fixed in the front frame of the easel. C is a grooved front ledge to support the easel glass. D is a light, rectangular frame of thin pine, which slides easily in the two grooved ledgers behind the front legs. This frame is covered with white tissue paper, and serves as a screen to modify and distribute the light transmitted through it. E is a light frame to be covered with brown paper, or is a flap shade of millboard or cardboard, either being useful to modify light or shade on the work. This can be set to any required height by means of the knotted strings, E E, which slide in the slots or saw-kerfs in

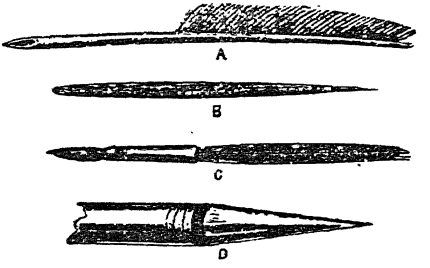


FIG. 8.

the top of the upright, A A. Sometimes this shade consists of a very light wooden frame covered with brown paper.

Glass-painters' easels can be obtained of several metropolitan artists' colourmen, notably Messrs. Brodie and Middleton, of Long Acre, and Messrs. Lechertier Barbe and Co., of Regent Street, or any joiner can make one from sketch and instruction; neither should there be any difficulty in the reader constructing one for himself, if only moderately deft in the use of joiners' tools.

The brushes used are not of much variety of shape, but each form should be kept in several sizes (see fig. 7).

For outlining, "tracers" (Nos. 1 and 2), or fine sable or camel-hair pencils in quills, are required. The hairs of these are longer than in ordinary brushes, and run from $\frac{3}{4}$in. to $1\frac{1}{4}$in.,

according to size. In selecting, care should be taken to choose those which come to a true and accurate point. Hair that possesses a certain elasticity is better than that they be too soft.

For applying the various colours and the stain, brushes and hair pencils of the same descriptions and forms as those used by artists generally are needed. Flat camel-hair brushes in metal mounts are best adapted for the work, although some glass-painters prefer sable brushes; either should be had in various sizes. "Stipplers" play an important part in glass-

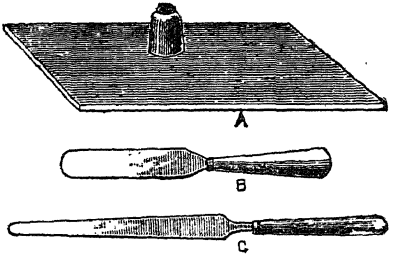


Fig. 9.

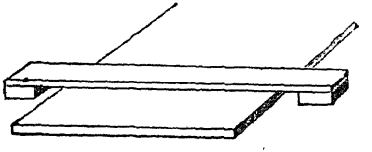


Fig. 10.

painting. These are something like ordinary "sash tools," but with a very flat end. Badger-hair "softeners" are employed for bringing flat washes to a perfectly uniform surface. A very essential species of brush is the "scrub." These can be bought or made by cutting the ends of the hairs of a common hog's-hair "fitch" diagonally, either from one side to the other or

from the centre to each side. If the fitch be a small one, only about 3-16in. of hair should be left above the tin on the short side. "Scrubs" are used, as their name imports, for scrubbing off paint from places where "lights" are required, as in the elevated portions of folds of drapery, &c.

Certain pointed implements, not of the nature of brushes, are indispensable for "taking out lights," or removing portions of the painted surface. Such are the "stylus" (D, fig. 8), a stick of any hard wood, with a somewhat obtuse point, the "quill" made of a goose quill, cut pen-shaped, but not slit, and the "etching needle" or needle point set in a wooden handle. These are shown at A, B, and C, fig. 8. A glass slab and muller (A, fig. 9) is required for mixing and preparing colours, also a small palette knife (B or C, fig. 9). Lastly, a mahogany hand rest (fig. 10), is an advisable adjunct, to steady the hand during tracing. This is of the form shown, and about 1ft. 6in. or 2ft. long, by 2in. in width. The painter can easily make one for himself.

Glass-painting is done in two styles, known respectively as "mosaic" and "enamel." In the first the main effects of the window are produced by using coloured glass and applying paint to it only where necessary. In "enamelled" work white (or colourless) glass is used, and all the effects are produced by the application of colour. Considering first the materials necessary for mosaic work, we require the colours, the medium, and the stain. The colours employed consist of metallic oxides, mixed with a flux containing boracic acid. When the piece of painted glass is "fired" or "kilned," the heat and the action of the flux cause the pigments to melt, and the surface of the glass to become soft and to a certain degree absorbent, and this process results in the colours becoming "burnt in" the glass. Proper "glass colours" are sold in powder in glass capsules, such capsules varying in price according to the market value of the pigment contained. The colours comprise tracing and other blacks, tracing and other browns, "grissaille" or grey, tracing and other reds, three blues, two purples, crimson, orange, green, and "matt" white.

CHAPTER V.

FIRING PATTERNS, ETC.

Of course, the size of the kiln or furnace used for firing painted glass will depend upon the amount of work to be done—*i.e.*, the size of the muffle containing the pieces of painted glass, which will require to be inserted. We have recommended the glass-painter to send his work to a professional for firing, and we are perfectly convinced that that advice is thoroughly sound. Still, as some people like to carry out all operations connected with their work for themselves, and also as some reader in the provinces or the colonies might not be near a place where he could get his glass kilned, we think it well to add some details of a small furnace, which any bricklayer could build or many handy people construct for themselves, premising that it was given about forty years ago by Mr. Nathaniel Whittock. Here fig. 1 is the elevation, fig. 2 a section, fig. 3 the plan, and fig. 4 a perspective sketch of the muffle.

Fig. 1 shows the front of the kiln when properly erected. C is the ash-hole, B the iron doors, by which the kiln is supplied with fuel. A is the door in the mouth of the kiln; this is made of sheet iron. By turning the handle in the centre the aperture above and below it opens and shuts, so that the condition of the glass may be observed while firing. In the flue, at some distance above the mouth of the kiln, a damper, D, is placed to regulate the heat.

In the section, fig. 2, A A is the brickwork, carried up to the height of 2ft. 9in., leaving the space, B, for an ash-hole. Over the ash-hole is placed an iron bar to support the grating at B. The brickwork is then carried up two courses from the grating, the sides sloping 3in. back from the uprights, as seen at C C. On this wall two stout iron bars, D, are placed to support the muffle; these bars are 20in. long and an inch thick. From the place where the bar rests an arch is turned, leaving a clear space

of 4in. round the muffle, so that the flames may play around it on all sides. The flue is carried up at the back from the top of the wall that supports the grating. In the flue, 18in. from the top of the arch, is fixed, in front, a common sliding iron damper.

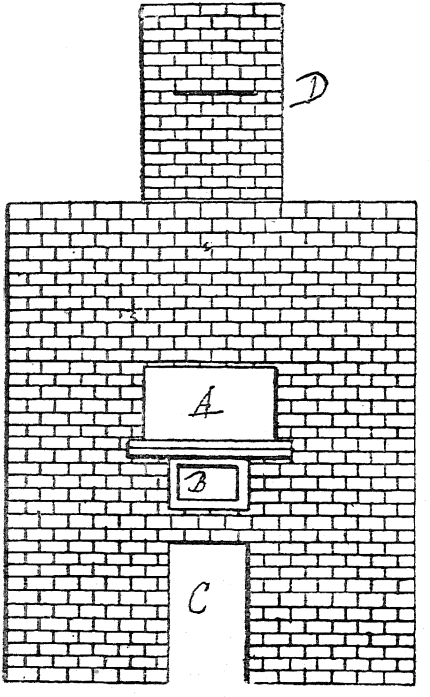


FIG. 1.

This is marked E. The flue may be carried up as most convenient.

We here adduce some simple examples of "quarry" and secular glazing. Fig. 5 shows a very common species of simple

quarries (squares), with a border of narrow parallelograms. The glass in these windows, as in the stained glass windows of churches, is fixing in narrow strips of lead termed technically "calmes." These calmes are made by drawing a slip of lead through dies of the proper form, which leaves the calme with a section as shown at fig. 5—viz., a central rib or portion, with overlapping edges. The glass is inserted between those edges, and the lead pressed down in it. The calmes are easily bent to any curvature desired. At fig. 6 is shown the initial steps of glazing a simple quarry casement. Against the slip of lath screwed down to the shop-bench at right angles, as shown, a couple of calmes, E, F, are placed and secured in position by tacks, *k l*. The first square, *i*, is then fitted into the corner of the calmes, then a short bar of calme of the length of the quarry, then another square of glass, another calme, and so on. When one row is thus completed, a length of best lead is placed along them, and on this the second row is built up, and so on till the casement is completed. The various joins of the fret lead are then secured by a few drops of molten solder. Fig. 7 shows a casement with diamond panes and borders. Fig. 8 shows two simple patterns, and fig. 9 two others of what are termed "strapwork" patterns. Figs. 10, 11, 12 show designs (from Messrs. Connelly's catalogue) well adapted for secular glazing, and figs. 13, 14, and 15 give others ornamented with the cheaper patterns now popular.

With regard to figure subjects in church windows or those of large secular edifices, there is a detail in connection with this kind of work which did not crop up in quarry glazing. It is this: However carefully the glazier may have cut out the glass, it is quite possible that when he comes to glaze his window he may find some of his pieces do not exactly fit, and may be very slightly too big, through due allowance not being made for the thickness of the calme when cutting out from the outlines. Such pieces are to be reduced to shape (supposing, that is, that they are only slightly too large) by "grosing." We have alluded to this operation as probably in very extensive use amongst the Mediæval glaziers. When quite a small portion of a piece of glass is to be removed it can be "grosed" or bitten away carefully and fragment by fragment with a pair of pliers.

If the excess amounts to $\frac{1}{4}$in. or over, however, the glazier's diamond should be brought into requisition for its removal.

The glazing is begun from the centre. If the design be of a figure, it is better to start from the head. Around the piece of

glass selected a calme is carefully bent, taking care that the edges of the glass go fairly "home" in the channel or groove of the lead. The "calme" can be cut off with the knife figured amongst the tools. It must, of course, be cut off so that when the lead properly encircles the lid of glass the two ends "butt" together or meet exactly.

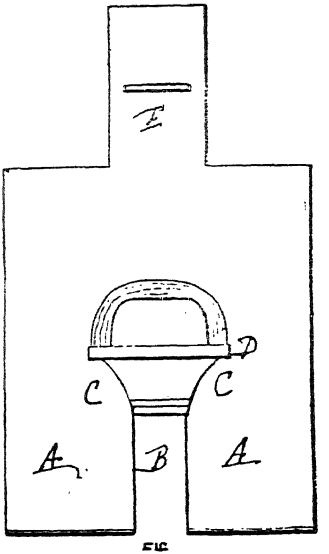


FIG. 2.

This central portion of leaded glass is then laid down in its proper place on the outline, and retained there by some nails driven into the board all round. One of the proper pieces of glass which come next to this centre one is then selected, fitted into the side of the calme around the other, a proper piece of lead fitted to each side of it or round it, and the whole secured by nails. Thus, from the point chosen as the centre or starting-place the whole of the pieces of cut glass are gradually pro-

perly assembled, with the lead calmes everywhere between them.

If, as is frequently the case, the glazier finds some of his pieces of glass have not been cut quite accurately according to the outline, he must "grose" them a little into the exact shape. The glass being thus assembled together in the leads, the next

FIG. 3.

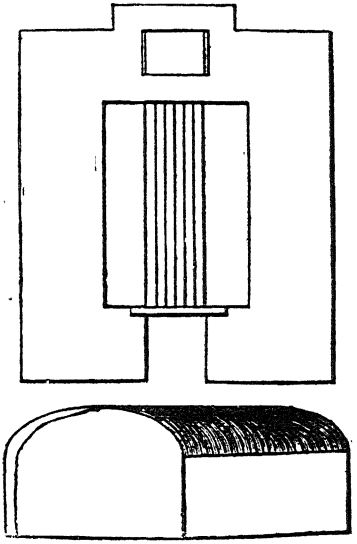


FIG. 4.

thing is to secure the latter at the junctions by a tiny bit of melted solder. For this purpose a soldering-iron and solder is required, and also some material to act as a flux.

The first may be the tinsmith's and gasfitter's copper bit, but at the present day what is termed the gas soldering-iron is generally preferred.

Solder is made in various qualities and of varying degrees of fusibility. Probably the glazier may not be able, or may be disinclined, to make his own solder. If so, he can purchase it at any glass warehouse or metal dealer's; but it is important that he sees to getting the right kind. What is termed "plumber's solder" will not do. "Strap" or "blowpipe solder" is the kind to be got. This is the sort used by gasfitters with the blow-

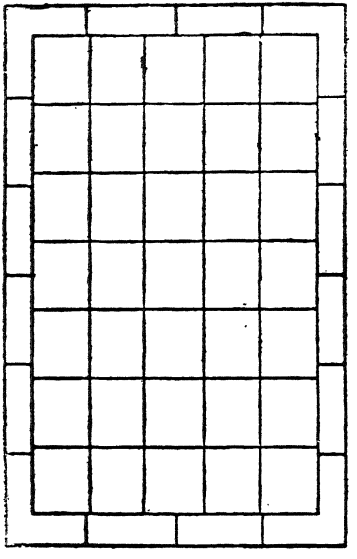


FIG. 5.

pipe, and is sold in strips of a bright, tinny appearance at 1s. per pound or thereabouts.

For the "flux," or medium to accelerate fusion, powdered black resin is frequently used, but what is known as "composite" candle is better for soldering "calmes." The soldering iron, whether it be the copper "bit" or the gas-heated iron just described, is to be heated (the former in a charcoal or coke

fire) until it is just sufficiently hot to melt the solder (with the aid of the flux) without also fusing the lead calme.

To find out whether it is so sprinkle a little powdered resin in the tin lid of a canister or any other piece of tinned iron. Rub the end of the hot bit hard in this until it becomes "tinned," or its point is covered with a thin coating of tin

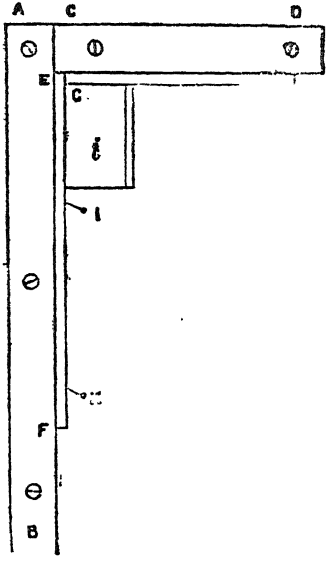


FIG. 6.

abstracted from the tin plate. Then hold a strip of the strap solder to its point, and judge of the effect. If of the right temperature, the solder should fuse easily, but not become so fluid that it runs down like water. It is more difficult to test the heat of the gas soldering iron than that of the copper bit, but it can be managed with a little care. While the tool is getting to the proper temperature the operator should touch every junction of the calmes with the end of his composite candle—

just rub it lightly at the place; the very slightest application should be sufficient if it be done properly. Then, holding the hot iron in his right hand and the strip of solder in his left, the operator deftly makes the joint by melting off a drop or two of the solder on the exact point of union. To do this well, so as to present a neat appearance (which is of great importance in this class of work), requires considerable care and experience,

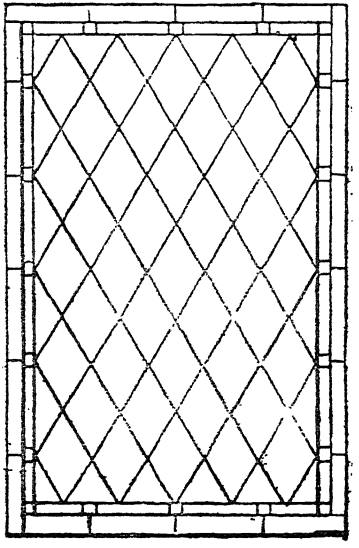


FIG. 7.

and the first efforts of a tyro are seldom very successful. It should always be borne in mind that the least possible quantity of solder sufficient to make a good joint only should be used. An ungainly lump of metal at the joint forms an unsightly excrescence, and is a sure sign of the botcher.

Sometimes it may be found that the solder attaches itself obstinately to the face of the bit and refuses to drop easily off

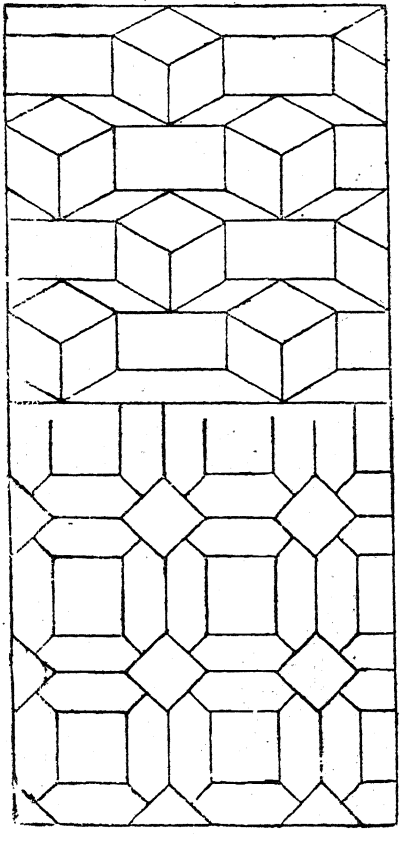


FIG. 8.

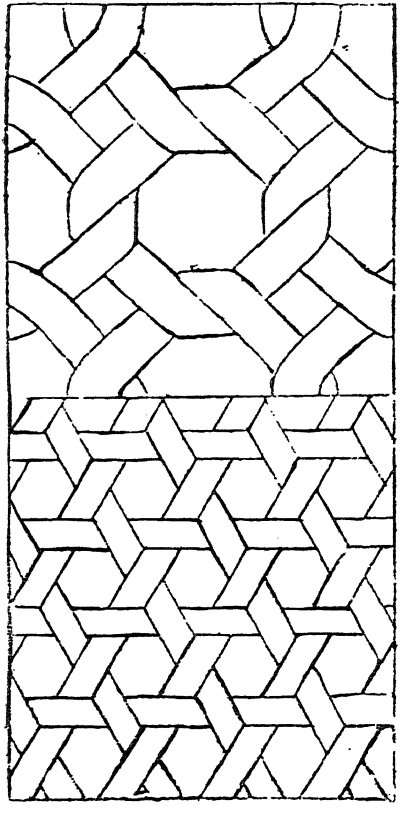


FIG. 9.

it. That is a proof that the end of the implement has become too much oxidized for service, in consequence of laying by, &c. In such cases the end of the tool should be filed bright, and when thus "refaced," it is to be "tinned" before using, by rubbing it in the resin powder on the piece of tinplate, as already described.

When the soldering of the window is finished, there is still something to do before it is completed. That is what is termed the "cementing." "Cementing" consists in the introduction into the channel of the calmes on each side of the glass of a suitable material which shall fill and close up each channel.

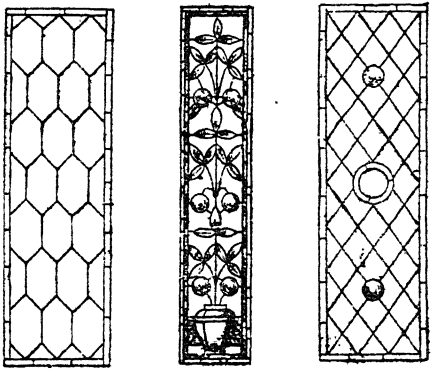


FIG. 10.

Thereby wind and moisture are effectually prevented from penetrating the window, and the pieces of glass are firmly fixed in the calmes, so that no objectionable clattering is heard when the wind blows upon the window.

The cement most usually employed is prepared as follows: A ball of ordinary whiting, well reduced to powder, is put into a pipkin or paint-pot. To this is added sufficient red lead and lampblack to make the mass of a dull slate colour that shall match the calmes. Boiled oil is added to the powder, and the mass is well mixed until it is of about the consistency of green treacle. The light or panel is laid down flat, and the cement well

dubbed into the calmes with a worn paint-brush with stiff hairs. Wood sawdust is then spread over the whole surface of the glass, and cleaned off with a wisp of hay. The whole surface is then well rubbed over with a hard, short-haired flat brush, like a nail-brush, but larger, dipped in powdered whiting or plaster of paris. This should clear away any tallow adhering to the joints, if a candle has been used as flux, and polish the glass also. The brush is then applied, after sprinkling a little lampblack to it, to the calmes. A good brushing will give a black polish to these. The panel is then to be turned over, and the same process pursued with the other side. The window

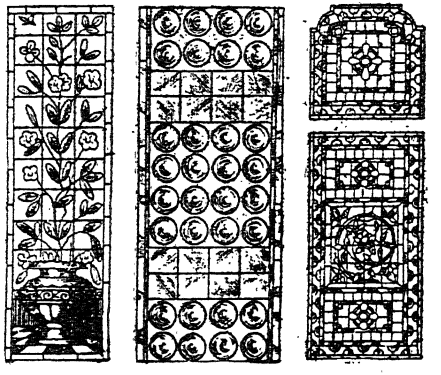


FIG. 11.

should then be left for a fortnight, a month, or more, according to the season, until the cement is thoroughly hardened. Some artists endeavour to give their windows more the appearance of ancient glass by coating them thinly with a varnish of beeswax and linseed oil. The process is not, however, to be recommended. At fig. 16 we give a couple more geometrical designs, one of them consisting of what is termed interlaced strapwork.

There is still one matter on which it is necessary that we should make a few observations in order to render the subject complete. This is concerning glass "etching." It is extremely useful in some portions of many stained-glass windows. For

example, if the robe of one of the figures of the window is required to be "diapered"—*i.e.*, covered with an ornamental pattern—this can be effected by etching. This is managed by the application of what chemists term "hydrofluoric acid" to the surface of flashed-coloured glass. The strong acid etches or eats away the coloured coating of the glass, leaving the pattern white or colourless. Hydrofluoric acid is prepared by pouring strong nitric acid on crushed fluor spar or Derbyshire spar, the resultant fluid being the only liquid that will dissolve glass. We will suppose, in order to exemplify the process, that a king's crimson robe covered with white or gold fleur de lys is required. The piece is cut out of flashed crimson glass, then the side which is "flashed," or coloured, is coated with "bruns-

FIG. 1'.

wick black," except the lily flowers, which are left uncoated. The hydrofluoric acid is then applied to these places with a rather stiff, short-haired brush, or, better still, poured on the glass, until the coloured coating is eaten quite away.

We now adduce some useful observations on cementing, &c., contributed by Mr. Richard Mathews to the *Illustrated Carpenter and Builder*, to wit:—

The cementing process, although it is considered a labourer's occupation, requires much attention to get the work to look clean and bright, and also to understand how to treat the different classes; some work being cemented, which is the usual way, and for some putty is worked into the leads with a putty or stopping knife, and some, for such as hall lamp panels, are not cemented at all, but are simply covered with sawdust and brushed with a stiff bass brush to polish them bright.

The usual method of cementing the work is to lay the panel flat upon the bench and rub the cement well into the leads, to fill it up, with a large stumpy paint brush. Then powder some whiting and cover the work with same, and rub it in with the hands, which is for the purpose of drying up the cement. Then take the stiff bass brush just mentioned and brush it quickly

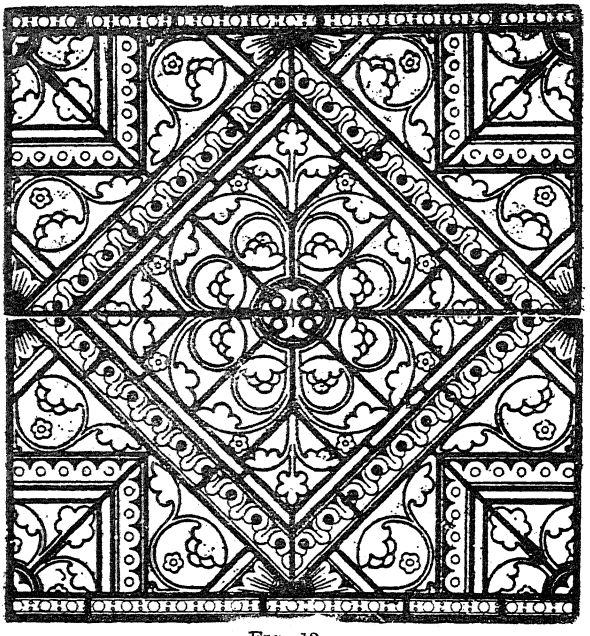


FIG. 13.

over the work, cleaning it roughly at first, and when the cement is rubbed in the other side of the panel, it will be prevented to a certain extent from squeezing through. The work is then turned over and treated in the same way, only it may be brushed off rather cleaner.

It is then picked out with a steel point by following the lead

and round each piece of glass. Then sweep off the refuse and brush the work briskly with the stiff brush. If the cement is required to be set extra quick plaster of paris may be dusted on and brushed in. After this, turn it over and do likewise, but picking this side out as clean as possible, finishing it off, and on the other side as well by polishing it up with a soft stove brush, using powdered black lead. After this it is held up before the light for a final pick out. In the case of painted work it is a

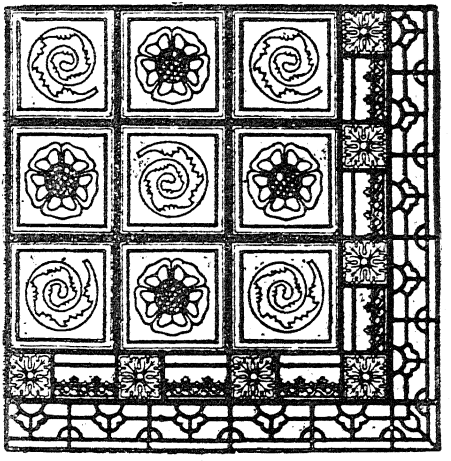


FIG. 14.

good plan to first work black putty into the lead with a knife on the paint side, and cement the other side, finishing the work off in the usual way. Instead of the steel pick being used on the paint side, a box or hardwood pick should be used so as not to disturb or scratch the paint which is not always quite fast upon the glass, as it should be. This side, after being brushed clean, is then sprinkled with sawdust and cleaned up with a stiff brush, and on no account must the black lead brush be used unless it be free from black lead, which corrodes the painting and is not

easy to clean off, but should it want cleaning, a piece of cloth dipped in turps or paraffin oil will do this.

The cement is made in different ways, the idea being to get it to set quickly and hard. The following composition will be found to be very good, and is made in a bowl or a paintpot large enough to hold about 7lb. To do this pound up whiting into a powder with a stick or pestle; then add linseed oil to make it the consistency of very soft putty, add litharge, about an eighth part of the quantity of the cement required; then add lampblack, to make it quite black, and thin out to a paste with

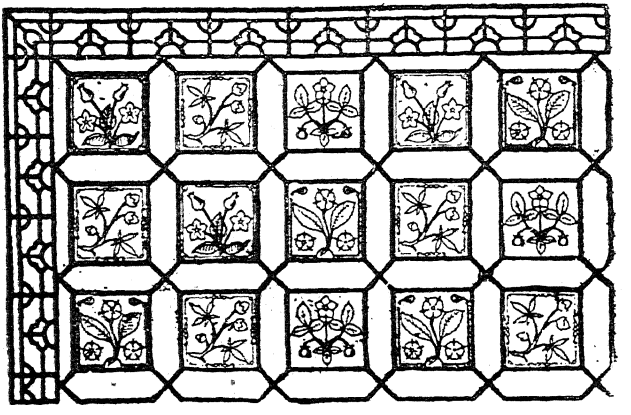


FIG. 15.

linseed oil and turpentine in equal quantities. Sometimes red lead is put into it, sometimes white lead, driers, copperas, &c., for quick drying purposes, and the work is all the better if it is left to stand according to its drying properties and afterwards finished off. If the leads are to be gilt or painted there is no occasion to use the blacklead brush, but should be brushed off quite clean with sawdust. In some instances of architects' particulars the soldered joints are specified to be polished bright, leaving the other parts black. The work having been cemented, the next thing to do is to prepare such panels as are necessary to be supported with bars for fixing into their places.

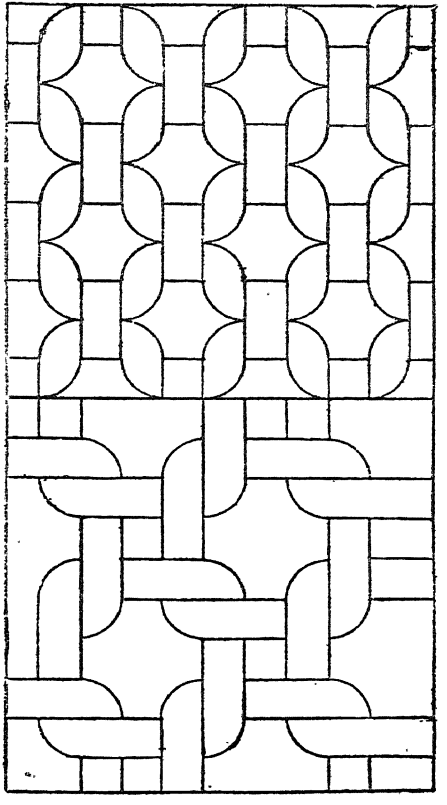


FIG. 16.

For this No. 16 copper wire is cut into lengths of about 4½in. with a pair of wire-cutting pliers, and soldered on across the most convenient part, to stay the body of the work. The flux for soldering these wires to the lead should be either resin or spirits of salts. They are fixed to the rough side of leaded work, and on the painted side of painted work. The bars are generally fixed inside, unless the work is tied to stanchion bars. The wires are then put on to come outside as well. Round bars are generally used for domestic work and square ones for churches, &c., according to the strength required, ranging from about ¼in. to ⅝in. They are mostly of iron, and are sometimes galvanized, but for good work brass-cased rod is used, and fixed usually in wood. In some cases the bars are bent and made to the shape of the lead, as it would not do to run them always straight across the panel, or they might cut an important part of the design. To do this an impression of the leads should be taken where the bar runs by placing white paper over it and rubbing it with heelball as a guide for the blacksmith, allowing ½in. to 1in. over in the length at each end, according to the measurement across and the body of work in the panel to be sustained. For door panels extra bars should be used, and for further strength the leads may be floated over with solder and cemented with good hard stuff. This applies especially to panels in public-house doors, that are always slamming, which very soon bulge and fall to pieces if not properly executed.

The next and last subject to treat on is that of fixing the work into the openings intended to receive it, whether in wood or iron sashes, gra ite, Bath stone, or brickwork. The man usually chosen to do this work is the glazier, and for some large firms one or two fixers are kept continually for the purpose. These men, as a rule, take all the particulars of the work as to size and shape, much care being required. Sometimes the whole of the work is spoiled through miscalculation in the measurements, or, perhaps, when cutting out templates to shapes of openings, they are forgotten to be marked as to whether they should be fixed right or left-handed, inside or outside, the top or bottom of the piece, size of the rebate or groove, &c. These remarks should be observed especially in tracery pieces of church work. The templates are cut out of stiff brown paper, at first roughly and by marking, and then cutting it with a pair of scissors until the right size and shape is obtained. The drawings or cutlines for these are made by marking round the

template of the right size and allowing ¼in. beyond this for the full size, so that when it is to be fixed the leaf of the lead on the outside of the work is turned back and fitted into the opening, and so by forcing and springing it into the groove intended for it. The leaf of the lead is then turned back to its original shape with the stopping knife, and wedged up with pieces of wood ready to be cemented. In the case of a long window being fixed, it is divided into parts large enough for convenient handling, and fitted together or built one upon the other, commencing with the bottom piece and working upwards. In some instances it is necessary to make tracery pieces in sections to get them to fit in, and small windows, where the leads are shaped, are made in two pieces previous to fitting in the windows in their places. The holes for the bars should be marked and cut out with an "iron chisel," including those for the stanchion bars, if any, before the work is fixed, otherwise there is a risk of breaking it. The hole on the left-hand side of the opening should be about ½in. deeper than the opposite side, so that the bars can be got into their places after the window is in the groove; it is then wedged up into the right position and the wires tied closely round the bars, turning them with flat-nosed pliers, and afterwards cutting the ends off and flattening the twisted tail to the bar. As a rule, these bars are fixed where the divisions come in a window, and the wires that are soldered to the piece above and below the bar are drawn and twisted round, which is the means of holding the work together as well as hiding the extra wide lead that is used to fit and lap over the small lead fitted on the piece of work below it. The window is then cemented or pointed up with a small trowel, using portland cement, roman cement being very seldom used, unless it is for such as granite work, as it becomes very hard, and, should there be occasion for any alteration after the work is fixed in the cement, it would be very difficult to do.

CHAPTER VI.

ETCHING AND EMBOSSING ON GLASS, ETC.

THE arts of etching and embossing glass are both quite modern processes, and in this are differentiated from glass painting, which, as we have shown, was known and practised centuries back. Etching and embossing do not probably date back for more than a half century. The vast improvements in the manufacture of plate glass doubtless caused architects and decorators to perceive the great ornamental potentialities of large sheets of massive glass in large public edifices. Municipal buildings and residential flats and hotels, and even in high-class public-houses, shop fascias executed in embossed glass are now very frequently to be seen, whereas, say, three decades ago, they were regarded as novelties.

Glass is etched by hydrofluoric gas or liquid hydrofluoric acid—*i.e.*, a solution of the gas in water. The former in contact with glass produces a rough surface, as in ground glass, while the latter ordinarily leaves the surface clear. The gas is prepared by mixing together finely-powdered fluor-spar calcium fluoride, three parts, and two parts of strong sulphuric acid in a shallow leaden dish, and applying a very gentle heat. The plates of glass to be etched may be placed over the dish. The operation should be conducted under a hood or in the open air, to avoid inhaling the pernicious fumes. The plates are prepared by coating them while warm with wax or paraffin, through which to the surface of the glass the design is cut with suitable gravers.

In preparing the liquid acid the mixture of spirit and oil of vitriol (sulphuric acid) is placed in a leaden or platinum retort, which is heated, and the gas given off is conducted into a leaden bottle partly filled with water, which absorbs it. Brought into contact with the fluor the acid virulently attacks it, producing stubborn sores. Fluoric (or hydrofluoric) acid is a colourless

liquid, sold by manufacturing chemists and some drysalters at prices varying from 1s. 6d. to 2s. per lb. when of full strength. The glass embosser, however, generally reduces the strength by adding about two-thirds the bulk of water—*i.e.*, say a quart of water is added to a pint of pure acid. Even thus reduced, however, the acid produces, upon exposure to the air, a white vapour of a pungent, irritating, and poisonous kind. As the acid attacks and dissolves glass it must be kept in a receptacle formed of lead, silver, platinum, india-rubber, or gutta-percha, those of the latter two substances being most used.

Beckmann, in his "History of Inventions," gives us some description of the methods of glass embossing in use in his day; but these have been almost entirely superseded by newer and much improved procedures.

The glass embosser has first to produce his pattern on the glass in some kind of "resist," to use a modern technical term—this resist being generally Brunswick black or black paint. Brunswick black can be procured of any artists' colourman or oilman. The usual method of procedure is to set out the pattern on a piece of tracing paper. The pattern or design should be sketched out first with a lead pencil and then carefully outlined with a writing pencil. The design being completed on the tracing paper, and showing equally well on either side, it is only necessary to turn the paper over to have the reverse of the design as it must be worked on to the surface of the glass.

It is the general practice with embossers to lay the glass flat on a bench or table, with the design under it, the reverse side of the tracing paper being uppermost. The design is then traced on to the glass with a sable pencil, the vehicle used being Brunswick black, the greatest care being necessary to prevent dust of any kind from mixing with or adhering to the black. When the whole design has been painted on the glass in this way, the straight lines may be improved by being cut up with a carpenter's chisel—a narrow one—passed along a straightedge. The black is easily cut or chipped off the glass, so that the greatest exactitude can be obtained in the several lines.

It being desirable that the hands should not touch the glass when the design is being painted upon it, experienced embossers use an arm-rest, which extends entirely across the glass, and this serves the same purpose as a mahl stick in writing on upright surfaces. This arm-rest is made of wood, of about 1in. in thickness. It is generally about 3in. or 4in.

wide, and the length is according to the requirements. A piece of wood at each end, of about 2in. in height, keeps it from touching the glass.

It is to be clearly understood that in using the black the colour is only to be applied where the glass is to be ground.

Before applying the acid the operator must be sure that the Brunswick black is thoroughly dry. It will take a few hours to become so—say, at least ten to twelve. The black is somewhat deceptive, as the surface will harden some while before the underneath portion does so. *Good* black should be used.

A bank or wall is now to be made around the plate. This ledge can be done by unskilled labour.

We will recapitulate the routine of proceeding. First, certain parts of the glass are covered with a "ground" or "resist," in this case Brunswick black. Secondly, the glass is then exposed to the action of a corrosive fluid, which attacks it but does not affect the ground, this fluid being hydrofluoric acid.

Coloured glass (if "flashed") lends itself readily to ornamentation by etching. The bright red glass known as "ruby" is mostly treated, and this species of glass is invariably "flashed"; a thin layer of coloured glass being blown upon the ordinary sheet glass, forming, as it were, a sort of thin veneer on one side only. Blue is also generally "flashed." The term "pot metal" is applied to glass which is more or less deeply coloured through its substance by fusion with metallic oxides. "Stained" glass differs somewhat from either of the preceding, the term being applied to the various shades, lemon, yellow, orange, and red (or very dark orange), which are produced by the peculiar dyeing or penetrating action of silver upon white glass after it is blown. They resemble "flashed" colours by being on the surface, but are frequently distributed on each side of the glass, whilst "flashing" is always confined to one side.

The art of embossing coloured glass merely consists in dissolving the thin veneer of colour fused on one side, and leaving the clear glass exposed in those parts from which the colour is removed. That being the case, it is manifest that embossing on either "stained" or "pot metal" glass is out of the question, the colours in the one case being sometimes on both sides, and in the other melted through the entire surface of the material. Ruby and blue which are "flashed," and known as "enamel" or surface colours, are most frequently employed for business purposes, either as lamp glasses or window transparencies, and

writing on these colours is easily effected. The lettering is first set out on a sheet of tracing paper of the same size as the glass; the glass is then placed flat upon the paper, which, having been turned over, presents the writing backwards, and the letters are traced on it with a sable pencil charged with Brunswick black. If the letters are intended to be white on the ruby or blue, they must be left open, and the whole of the glass covered with the Brunswick black with the exception of the letters. If, on the other hand, the letters have to be left red or blue, they alone should be written with the Brunswick black, and the broad surface of the glass untouched. After the Brunswick black is quite dry a border of soft soap is to be built around the plate of common Russian tallow, or any kind of soft wax, which should be laid on with a glazier's putty knife, to the height of about half an inch all round.

The work is now ready to receive the fluoric acid. This should be poured on evenly all over, to the depth of about a quarter of an inch; and in order that it may not have a greater depth on one side than the other, a few wooden wedges will be found of service, or the glass may be made perfectly level by means of an ordinary spirit level, before the acid is applied. Unless the glass be level and the acid flow evenly over the whole surface, the pattern will be bitten in deeper in some places than in others, and it may happen that the grinding afterwards will be unsatisfactory. This is one reason why the common sheet glass is not used by embossers; its surface being wavy, the acid would lie about in pools, and the biting-in would be irregular. And, again, if the surface had to be obscured, the grinding would be most unsatisfactory, as the projections would receive a portion of the rubbing which ought to belong to the indentations, and different degrees of opacity would be apparent, unless the operator spent a vast amount of time and labour in remedying the defect. After the acid has remained on the glass for half an hour, or an hour, it may be drained off.* A breach should be made in the wall of wax at one corner, and the liquid, as it runs off, should be caught in the bottle in which it is kept, as it may be used again and again.

In using fluoric acid the operator must exercise great caution, the properties of the acid being most destructive to animal

* The length of time necessary for eating out the patterns depends, of course, upon the strength of the acid and the hardness of the glass, and therefore it is advisable to try a small piece before proceeding with any large or important work.

matter. It should not be permitted to touch the hands, and if by accident it should do so, the acid should at once be washed off with cold water and the hands wiped dry. The white fumes which ascend when the acid is poured on the glass are very deleterious, and must on no account be inhaled. The embosser should stand as much away from his work as possible, and on no account hold his head over it.

The glass is next to be cleansed of the acid and the Brunswick black. The former can be rinsed off with cold water, the black scraped off with a knife, followed by potash lye or turps, and this latter removed by soap and water.

The surface of the plate has now to be "ground" with a flat block of copper or a slab of ground glass, used with fine emery and water. The glass plate should first be placed upon a base of some soft material, such as baize or blanketting, and the supporting surface should be perfectly level.

Our American cousins at one time imported their glass from Europe. They have now taken up its manufacture, and in many respects have adopted improved processes. The following account of the industry with them (taken from the *Scientific American* of some years back) is interesting and instructive. In that paper a large engraving was given representing an American stained-glass worker's *atelier*, with work in operation. This writer observes :—

There are few arts combining both the useful and ornamental that add so much to the gratification of the public as the introduction of stained glass windows in edifices, whether public or private. To so temper the glare of light passing through an opening in the wall and render it a source of pleasure to the eye by means of harmonious colours, is the study of the stained-glass window producers.

In church edifices this use of colours in windows has now become quite general, and to meet the æsthetic demand, glass makers and artists are taxed in devising new shades and designs to meet the local or sentimental tastes.

For design, it is quite natural that the great field of Scripture should furnish an endless variety of central subjects, while a framing may be composed by a harmony of flower, leaf, and scroll.

In arranging a window the artist is first governed by the cost of the materials and the sum allowed for the finished work. That being stated, he arranges the sash space into the most beautiful and appropriate design that the pecuniary limit will

allow. The design is first arranged on a small water-coloured sketch, then enlarged to full size by pencil outline on heavy manila paper. Each of the parts of the design are now cut out by use of double shears. These shears are made double for the purpose of cutting away as much of the paper on the line as will compensate for the thickness of the leads that join all the various pieces together. A simple design is made, and cut into parts, and a tack fixed through each to keep them in place on a board, and from which they are removed to lay upon the glass, while a diamond or wheel follows their edge as a guide in cutting. There are five different sizes of leads used, the height being the same, but of varying widths of face presented; the double shear concerns, of course, only the upright standard portion of the lead.

At this point, the taste of the artist is further supplemented by the skill and eye of the glass selecter. From a profusion of coloured glasses, with surfaces of smooth or roughened texture, as required, he selects the quality and colour he thinks most effective for the location. This he writes upon each piece of the design, and then they are given over to the glass-cutter.

The glasses most used are prime colours—ruby, blue, amber, purple, and green. In addition to these are plain hammered cathedral (all shades), antique, variegated cathedral of two or more shades, blended brown and amber, brown and blue, brown and pink, olive and amber, imported Venetian, American Venetian, ondoyant, and, the most useful of all, opalescent glass. Most of these varieties are made in this country and are prized for their clearness. The surfaces are in all designs and degrees of coruscation.

If the window is to have figures included in the design, or portions that require special treatment, then the work, such as portraits, hands, feet, animals, &c., is painted with metallic colours on plain glass and "burned in" in a gasoline heated muffle furnace. This requires great skill and management in gradual raising of the temperature to the flowing point, and final slow cooling. Even with the greatest care, fine bits of painting are sometimes cracked and ruined in the furnace, necessitating a repetition of the work.

Having all the various pieces of glass prepared and laid upon their corresponding part of the paper design, the board upon which they rest is removed to a large table, where, in a square corner of the table, two pieces of the lead are mitred and placed against the right angle sides of the elevated edges. The first

corner piece is placed in the groove of the lead, a short piece is cut the length of the lower edge and another for the angle end and side. The workman is provided with a hook-shaped knife, this form being the best to work with, with which he easily cuts the soft leads, while the weighted opposite end of the knife-handle serves as a tamping hammer.

A second piece then follows in its place, and is similarly surrounded with the grooved leads; curved edges are readily placed by the very plastic lead. Occasional measurements are taken, and with a soft wood guard the work is tamped up to reduce any enlargement of work by crooks in the intervening leads.

When the pieces are all in their appropriate places the workman goes over every joining of the leads with a soldering-iron and solder, thus fastening the whole together. This necessarily must be done with both sides. To make a window rainproof the glass must be puttied in to the sash. The leads are made slightly deeper than the thickness of the glass for this provision. And now the workman daubs thin putty over the whole glass, and with a handless broom he sweeps in every direction over the window and drives the putty into the spaces, finally cleaning off the surplus by a bath of sawdust and a vigorous brushing.

Nothing remains to do now but put the glass in the sash, set it up as shown, and wire it securely to thin crossbars for security from high winds, &c.

We are indebted to Chicago firms for information and sketches pertaining to this industry, and it is a pleasure to us to speak our gratification of the work done, both in an artistic and workmanlike manner, by Messrs. Geo. E. Androvette and Co., Flanagan and Biedenweg, and the Wells Art Glass Company, of Chicago. We are pleased to know that many churches, private residences, and places of trade are beautified with their products.

The proper method of affixing white enamel letters to glass does not appear to be understood as well as it might be, judging from the many missing letters apparent in this class of work on our thoroughfares. The best method of fixing letters of this class is as follows: First thoroughly clean the window, taking special care that no grease is allowed to remain on the surface; then mark on the outside with chalk or soap the outlines of the design that it is intended to adopt, using the straightedge and a piece of string for the curved lines, as may be required. Divide

the guide lines, then roughly outline the positions of the letters. Now take some cement, made of two parts of white lead ground in oil and three parts of dry white lead, and then mixed to the consistency of soft putty with good copal or furniture varnish. Apply the cement to the back of the letters with a knife, laying it on equally round about the inside edges. Then take the letter, place it against the glass and work it up and down, and from side to side, pressing carefully until all the air is expelled, and a good adhesion is secured. Take care to press equally on the parts of the letter, so as not to cause a break and, if the weather be warm, apply small pieces of sealing wax or gelatine lozenges, such as are sold at all sweetstuff shops, to the under part of the letters in order to support them while drying. Then take a piece of wood sharpened at the end, dip it in water and clean off all surplus cement, wetting the stick as often as may be required.

Take care that no openings are left in the sides of the letters, especially at the top, where rain would be likely to get in and detach them from their surface. In mixing the cement it is well to use a palette knife to render it perfectly smooth, mixing the parts together in the same way as colour would be treated. In cementing large size letters it is advisable to leave them for an hour after placing the cement round the edges, and then to apply a second coat of cement, the idea being to do away with the considerable thickness of soft cement that would be the result of applying it all at once.

To remove enamel letters from glass apply petroleum or kerosene oil to the top of the letters, which will after a little time soak along the surface of the cement, enabling them to be removed at will. Another way is to scratch round the edges of the letters, removing all the cement from under the surface by means of a very thin knife or piece of thin sheet steel.

CHAPTER VII.

STAINED AND PAINTED GLASS; MIRRORS AND ORNAMENTAL GLASS.

"TRUTH," someone has said, "never can be confirmed enough," and nowhere does this statement apply with greater force than in matters of art.

When a truth has once found acceptance, the wonder is that there should be any temptation to depart from it; yet history shows that whenever art has flourished or declined, its rise or fall has been the result of its adherence to, or departure from, the laws which govern it.

All the arts cluster around that of architecture as the source from which they derived their being. "Men built houses before carving them, and carved before painting them," says Viollet-le-Duc. Sculpture and painting are, therefore, but help-meets of architecture, sustaining independent and harmonious relations each to each when justly balanced. We have so long lost sight of this truth, and are so accustomed to regard sculpture and painting as independent arts, each sufficient unto itself, that it requires an effort to realize that in the beginning both arts were evolved as accessories to architecture, and that there was no sculpture nor painting except as decorative adjuncts.

The evolution of the stained-glass window may be traced step by step to this fountain-head of all the arts, for the stained window is only an offshoot of the earlier art of painting, which had at first only a decorative function. Painting at the very outset was of the nature of symbolic representation, and was one of the earliest arts in which the creative faculty of primitive man was brought into play. It was this symbolic art which the early Christians appropriated to their use, for various reasons. First, because of its suggestiveness and power of appealing to the imagination of the illiterate,

who were to be instructed in the faith ; second, because, while having a peculiar significance to the initiated, it guarded the mysteries of the brotherhood from hostile scrutiny ; also be-

STAINED GLASS : THE CARPENTER.

cause there was at that time a dislike of direct representation of the Deity. These were the practical ends which religious symbolism was designed to serve. But as the Church grew in

wealth and power, it began to feel that one of the ways of glorifying God was in beautifying His temple; so beauty and utility conspired and caused to exist some of the sublimist creations the human mind could conceive. By degrees this symbolism grew into a more literal portrayal of Church history and tradition, so that the walls of Roman and Byzantine interiors were decorated with frescoes representing scriptural scenes, the apostles, saints, and martyrs. These interiors, owing to the small window openings, were lighted for the sacred service by artificial means, tapestries often being hung over the windows. But when stained glass made its appearance in the twelfth century, probably from some Oriental source, Churchmen were quick to transfer their decorations from the opaque and poorly-lighted walls to the translucent surfaces of the windows.

In effecting this change, however, they did not lose sight of the fact that their window ornament, as well as their wall decoration, was to be kept subordinate to and in harmony with the architectural surrounding. All antique work is distinguished by this strict adherence to decorative principles, which does not permit either sculptured or painted ornament to transcend certain limits.

Stained-glass design, particularly of the earlier Romanesque period, had generally the effect of tapestry. The figure and all natural forms, when used as motifs, were severely conventionalized and in one plane; consequently without perspective or chiaroscuro. We may be able to determine exactly what constitutes the essentials of good stained glass, and what its proper treatment should be, by noting the properties of the antique art when at its best, and if we can rightly understand the cause of the decline of the stained window in the sixteenth century, we may save from a similar fate that of the nineteenth century.

The advent of the Gothic style, with its reduced wall spaces and larger window openings, was the opportunity of the glass worker of the twelfth century. To fill these vast openings with some material which should at once exclude the weather and admit the light was his task, and as the antique glass could be made only in pieces of limited size, it became necessary to build up a mosaic of numerous pieces, joined by strips of lead, in order to make panes of area equal to the windows.

Throughout the Mediæval period this mosaic method was strictly adhered to. The artists recognised the limitations laid upon them by the nature of their material, their designs being

mostly confined to the arrangement of pieces of coloured glass in geometrical and other fanciful patterns. They made no effort to conceal the unavoidable lead lines, but rather forced these to perform certain functions in the artistic as well as mechanical economy of their windows. But they refrained from attempting to make pictures out of them, and during this period of more than 300 years there is no instance of an attempt at realistic portraiture. The antique workman was content to get the most out of his material in the way of gorgeous colouring. Design was of secondary importance and restricted in range.

The peculiar virtues of Mediæval windows were due to the quality of the glass they had at hand. In its manufacture their knowledge as well as facilities were extremely meagre, and their small knowledge of chemistry gave them a very limited palette. But this handicap was itself the cause of much of the beauty of their raw material. Being obliged to make it in small pieces, they were necessarily forced to retain the mosaic process; this was well for the art. Then, too, their glass was heavy, of unequal thickness, full of bubbles, coarse-grained, and of uneven texture. All these mechanical defects made the antique glass the ideal material for mosaic windows; they made it scintillating and luminous, full of deep, mysterious colourings, making thinness and monotony impossible. Such was the best estate of the glorious old Mediæval window, "casting a dim religious light," of which the poet sings.

Now, what was the cause of the decline? With the fifteenth century came the Renaissance, and with it the new form of art, oil-painting. Just at this juncture certain mechanical improvements were made in the fabrication of glass. Vitrifiable or enamel colours for glass-painting were also discovered, and a yellow stain made from silver. These conspired to overthrow the old art of mosaic. In the first place, the improved method of glass manufacture produced a more mechanically perfect material. It gave larger panes, uniform in thickness, smoother in texture, and more homogeneous—*i.e.*, more compact, without the air-bubbles which gave the gem-like effect. These changes alone meant loss of vitality in the material itself. It became thin, weak, and monotonous. Then the invention of enamel colours led the artist to attempt the imitation of the effects of oil-painting. This was particularly harmful. The craftsman threw away his fine old glass, and took the new smooth material upon which he could paint, loading it with the opaque

enamel, and still further deadening the glass which had already lost its vitality.

Of course, it proved impossible to make a realistic picture in glass. The hard lead lines bounding the different planes of the perspective destroyed all pictorial illusion; so, like the dog in the fable who saw his reflection in the water, the old artist dropped a choice morsel to seize a shadow, and—lost all. For three hundred years he had followed Truth. When he forsook her his art disappeared.

The art of painting on glass is known to have been practised, and to have been applied as a decorative medium, as early as the sixth century in the church of St. Sophia and similar edifices in Constantinople, and to a considerable extent during the reign of Charlemagne, although it was not commonly used until along in the tenth century, after which it was much admired and patronized, and advanced rapidly to excellence. Panels, which captivated the eye by their brilliancy and colour effect, were first employed by the monks of the Abbey of Riveaux, in the North of England. They discovered a taste for enriching their convents with fine decorative glass brought from France about the year 1140, although the cathedral of Canterbury, which suffered by fire about the year 1067, contained many fine specimens of decorative glass, now lost. The combination of colours was the sole charm to which the painter could lay claim. The merit of a beautiful outline, one which exhibits grace, purity, and correctness of form, was utterly neglected. Decorative glass, whether painted or the colour otherwise obtained, should always hold to its transparency and liveliness of colour, which constitutes the most beautiful feature of this art. A certain quaint simplicity seems to me to be characteristic of all good stained glass. Highly ornate, pictorial treatment is, on the other hand, fatal to successful results.

In all cases glass should be treated with special reference to the form, style, and purpose for which it is intended, thus making it worthy to be copied by future generations. Style alone with me signifies individuality, but individual style combined with Classical style denotes genius. It would be idle to pretend to ignore the latter. I am sorry to say that very few of the designers and decorators of our country in former years show distinctly the style of any one period. They exhibit the style of the designer and the designer alone. Those who would like to verify for themselves what I mean by style showing individuality can do so by referring to the works of any of our

well-known decorative craftsmen and designers. The late B. J. Talbert, well known to many of us, is a striking instance where a man has left his stamp of individuality upon all he did.

STAINED GLASS : THE CARVER.

In my own small way I have always endeavoured to steer clear of the conventionality of style, which is the bane of so many designers. The source of all designs is nature; the

difference in work arises from the treatment of natural forms, so as to adapt them to the requirements of decoration. I hold that the designer should not merely reproduce what already exists, but create something suggestive of the present day. It is often urged that as in matters of taste fashion is so variable, some new style of decoration might be introduced; but the fallacy of this idea will be exploded upon considering that every principal apartment has a distinctive character, together with the style of architecture; the treatment either in glass or otherwise, should be carefully studied. The ceiling, cornice, walls, woodwork, &c., should always harmonize with the surroundings, for in this harmony lies the keynote of success.

Man does not create, he only adapts. Why believe ourselves capable of producing or conceiving more beautiful forms than those of nature? Nature and art go hand-in-hand in every artistic effort. Every way side presents an abundance of flowers, whose forms are as graceful as their colours are beautiful.

Every interior, properly considered, has its own distinctive style of decoration. The people of Pompeii seem to have been aware of this fact when they had their principal apartments decorated in a way to endure as long as the structures themselves. Raphael, no doubt, entertained a similar opinion when he executed the chief portions of those exquisite ornamental details that adorn the vestibule of the Vatican, which after the lapse of three centuries, and amidst all the vagaries of fashion, still remains the wonder and admiration of the world.

Were the decorative arts appreciated and cultivated, as they ought to be, what boundless fields would be opened up for the exercise of genius, such as would bring full and profitable emp oyment to all. It is, however, sincerely to be hoped that a brighter day is now dawning.

Now, my dear fellow craftsmen, let each and every one of us, from this time on, it matters not to which branch of the craft we may belong, endeavour to adjust and make right what others have untruthfully done. This can only be brought about by our firm and steadfast progress to the front. It would be useless for us to cope single-handed, expecting to lay a true foundation for universal success. By uniting we shall not only gain success, but be authorities in our different branches.

The making of glass mirrors for commercial purposes was probably first developed in Venice. Looking-glasses in large sheets were exported from Venice in the last part of the seven-

teenth century. Mirrors became articles of household furniture in the early part of the sixteenth century. Previous to that time small pocket mirrors were carried at the girdles of ladies.

STAINED GLASS: THE CARPENTER.

They had no covers, but were furnished with a short handle. The old process of amalgamation is about done away with. The process of silvering was first introduced in 1840, through a

discovery made by Baron Liebig. A horizontal double-bottomed metallic table is used, which is heated with steam to from thirty-five degrees to forty degrees C.

The glass to be silvered is cleaned thoroughly with wet whiting, then washed with distilled water, and prepared for the silver with a sensitizing solution of tin, which is well rinsed off immediately before its removal to the silvering table. The table being raised to the proper temperature, the glass is laid, and the silvering solution at once poured over it before the heat of the table has time to dry any part of the surface of the glass. The solution used is prepared as follows: In half a litre of distilled water 100 grammes of nitrate of silver is dissolved; to this add liquid ammonia (sp. gr. 0·880) sixty-two grammes. The mixture is filtered, and made up to eight litres with distilled water, and 7·5 grammes of tartaric acid dissolved in thirty grammes water are mixed with the solution. About 2·5 litres are poured over the glass mètre to be silvered. The metal immediately begins to deposit on the glass, which is maintained at about forty degrees C. (104 degrees Fahr.), and in a little more than a half-hour a continuous coating of silver is formed.

The silvered surface is then cleaned by very cautiously wiping with a very soft chamois rubber and treated a second time with a solution like the first, but containing a double quantity of tartaric acid. This solution is applied in two portions, and thereafter the glass is once more cleared of all unattached silver and refuse and removed to a side room for backing up.

The plate glass before silvering is first bevelled on the roughing machine. To bevel the edges the sheet of glass is held up slightly on the edge by the attendant on to a horizontal revolving iron wheel. This wheel is about 30in. in diameter and about 1¼in. in thickness, and is slightly curved on top. Water and white Rockaway sand is added from a large cone-shaped hopper, which causes the wheel to grind down the edges of the glass.

The wheel is capable of bevelling 1ft. in about twenty minutes. From the rough bevelling machine the glass is run over a 30in. emery wheel. This cleans and takes out the sand from the pores of the glass. From the emery wheel it passes to a horizontal Newcastle stone wheel about 30in. in diameter, and about 3in. in thickness. This wheel smooths the surface of the bevelled edges, and is ready for the first polishing wheel. The polishing wheels are 34in. in diameter, 3in. thick, and made of poplar wood. It revolves in a perpendicular position, the

attendant pressing the bevelled edge against the face of the wheel, adding now and then a quantity of water and powdered pumice stone. This wheel leaves the edges a little cloudy from the pumice stone. To make the edges transparent they are run over another similar-shaped felt-covered wheel, the surface of which is covered with rouge.

A number of sheets of glass can be polished at the same time by laying a number of the sheets on a long cloth-covered table, over which, connected to a square horizontal shaft, are a number of iron frames. Inside of these frames polishing blocks are placed, the bottoms of which are covered with felt, and rest on the surface of the glass. These blocks are made of wood, and filled with lead, and weigh about 20lb. each.

The shaft which moves the blocks over the surface of the glass is set in motion by means of a crank attached to a wheel on the main shafting.

After polishing, the glass is taken to the silvering-room and washed and silvered as stated above. Some silvering tables are made of hardwood, being about 1½ft. in depth, with a metal top. The interior contains about 6in. of water, heated by coils of pipe laid across the bottom. The tables are about 12ft. in length, and 7ft. in width. Iron slabs are laid over the top of table and covered with Canton flannel, on which the glass is placed to be silvered. It takes about two and a half hours to dry, and then the backs are painted. Some silverers use harts-horn and Rochelle salts in their solutions.

CHAPTER VIII.

PLANNING AND PLACING WINDOWS, LIGHTING, ETC.

THE planning and placing of windows is a matter more for the architect than the glazier. It is necessary, however, that he should know something of the design and use of windows for lighting. It is extremely difficult to lay down any law giving exact rules as to the proportion of lighting space necessary for a given room. Much depends, for instance, on the position of the light. In the well-known example of the Pantheon at Rome, the building is amply lighted by a small circular opening in the roof. The contents of this building are given at 1,934,460 cubic feet, and the area of the circular opening is only 527ft., or about one-third of the amount required had the lighting been from the side. The rule said to have been adopted by Sir William Chambers is to add the depth and height of the room together, and an eighth of the result will give the width of the window. Gwilt gives as a general rule 1ft. super. of light in a vertical wall to every 100 cubic feet in the room. Robert Morris says that the superficial area of the window should equal the square root of the cubical contents of the room. This, however, though no doubt approximately true, must evidently be open to large variation, according to the width of the street, and especially according to the aspect and the climate; and the exact size of certain windows to suit certain shaped rooms can only be learnt by observation and experience. The matter is one of the greatest importance, and cannot be too carefully considered. It should also be borne in mind that certain rooms will require more lighting than others—a drawing-room more than a dining-room, a dressing-room more than a bedroom, and so on; and if this is carefully attended to (and, of course, taste and discrimination used), the elevation will be at least an honest and truthful one,

and you will not find the principal windows on the ground-floor lighting, as is often the case, a cloakroom or a water-closet.

Though, however, there are no actual rules to guide us in this all-important question of the distributio of the lighting area, there are many reasons which may affect our arrangements, and this is the most important part of the subject. The main objects to be aimed at are two in number—firstly, the effects of the arrangements as seen from the room; and secondly, the effect on the external elevation; and it is the judicious application of the window to suit both the internal and external requirements that calls forth some of the highest qualities of the architect. The internal effect is placed first, as being the most important, though, of course, no design can be considered satisfactory which does not meet both requirements. The first axiom that may be laid down under this head is, that wherever a room is so large that one well-proportioned window will not properly light it, then that room (assuming the light is from one side only) must have *three* windows, not necessarily of equal size, for it may have one large and two small; but it should on no account have a even number of windows in one side. No doubt it has been noticed, on going into a room lighted with two windows in one side, that there is something unsatisfactory about it—the room strikes one as gloomy, because there is a pier where there should be a window; yet hundreds of town houses are built entirely ignoring this first principle, and generally, again, "to preserve the uniformity of the elevation," which is usually divided into three bays. Thus the ground floor has an entrance door and two windows, and the remaining floors three windows each. The result is that the dining room strikes one as gloomy, with its large central pier between its two windows.

The drawing-room is usually well-lighted, and the best room in the house, having a centre window; but above this, again, the window over the porch in each floor lights a small room, sometimes a dressing-room; and the principal bedrooms, again, have a pier in the centre, with the same gloomy result noticed in the dining-room—the disadvantage here being largely increased by the difficulty of properly arranging the furniture, a matter which should always be considered in the design of a room and the disposition of its windows. In this case the dressing-table must either stand between the windows, where the light will be very bad, or it must stand under one of the windows, when, being one of the principal pieces of furniture in the room, it will give the whole room a one-sided appearance. The windows are all double-hung sashes, with the exception, per-

haps, of some which are fixed, and usually the head of the window is some distance below the ceiling, in order to allow an elaborate cornice, full of builders' stock enrichments, to run its headlong course over the top of it; and often also there intervenes a little bit of wall space which the paperhanger finds is not large enough for one pattern on the paper, and so leaves it altogether, hoping the curtains hide it, as they often do, for there are no arrangements made for these or for the blinds, or, indeed, for anything. These dispositions of windows are given as what should be avoided, but as advice may be asked of some reader on the important subject of the design and use of windows, let us append the dictum of no less an architect than Mr. Aston Webb. He says :—

"The first great use of a window is the admission of light, full and sufficient. Gray speaks of 'rich windows that exclude the light, and passages that lead to nothing.' Modern architecture should not be open to this reproach. We read in the Bible that next after the creation of the world God said, 'Let there be light, and there was light;" and after that record it is not for man to say there shall be darkness, and exclude the light. Depend upon it, wherever this is done it is wrong. Light and sunbeams mean life and health to all men, and he who excludes the one excludes the other. The second great use of a window is that we may look out of it and enjoy the prospect, whatever it be, and any arrangement which does not admit of this we may at once recognise as wrong (though there are, of course, cases where no look-out is preferable to the only one to be obtained). The third great use of a window is the admission of air and the ventilation of our rooms, without which we could none of us 'live out half our days.' And, fourthly and lastly, if we attempt fairly to carry out these three great cardinal points in the arrangement of our windows, we shall find that our elevations will become more truthful and representative of the spirit of our age, and the architecture of the nineteenth century may continue to be worthy of the title bestowed on it as the 'printing-press of nations.'"

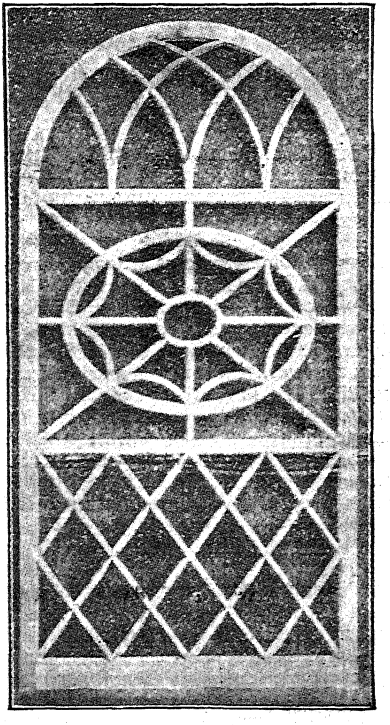
CHAPTER IX.

WOODEN MOULDINGS, OR ASTRAGALS, CURVED AND INTERLACED FORMS.—MACHINES FOR PRODUCING THESE.—DETAILS FOR FRENCH CASEMENTS.—IMITATION OF STAINED AND COLOURED GLASS.

THE mouldings of some windows are very ornate, wandering in interlaced patterns for effect. These wooden mouldings, to receive the glass, are mostly mitred by hand or turned in ovals or rounds, but we have recently seen a machine placed on the market by Messrs. J. B. Stone and Co., of Finsbury-pavement, which performs the work thoroughly and admirably. It is an American invention, and is the result of years of experiment in building a tool to get out all kinds of diamond, light, and fancy sash in the shortest time and at the lowest possible cost. With this tool the work can be got out in one quarter the time it would otherwise require, and therefore large profits can be made on work that is always slow and expensive to turn out when made in the old-fashioned way. It consists of a column and face plate, on which are mounted two swinging tables with clamping screws at the back to hold them at any angle in relation to the cutters. The cutter head is operated by the foot treadle, and carries two formed cutters (right and left) which are made the exact shape of the moulded outline of the sash, and they will therefore cut or trim the ends of bars and muntings just right to make a perfect joint at any angle. These cutters are made so that they can be sharpened like a common chisel, without changing their form, and they will last many years.

The sash-bar to be cut is laid on a wooden bed piece, which is grooved out to fit its lower side, and this supports it at the moment of cutting to prevent any splintering or breaking down of the edges. These bed pieces are mounted on tables which swing to any angle, and the tables are provided with spring-pins

and stops to make them instantly adjustable from one angle to another without any delay in resetting. In making all kinds of fancy sash it is very important that the bars and muntings run



WOODEN TRACERIED WINDOW.

in perfectly straight or evenly-curved lines, in order to obtain the correct and most satisfactory effect. This is where the machine has peculiar advantages over any other method of

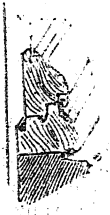


FIG. 1.

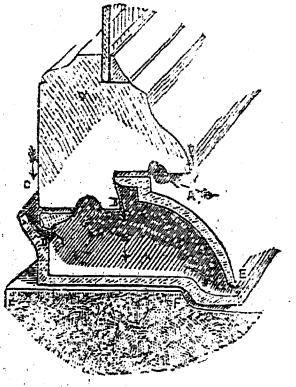


FIG. 2.

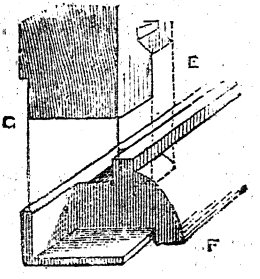


FIG. 3.

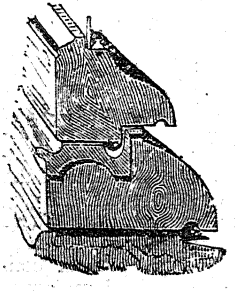


FIG. 4

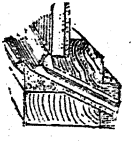


FIG. 6.

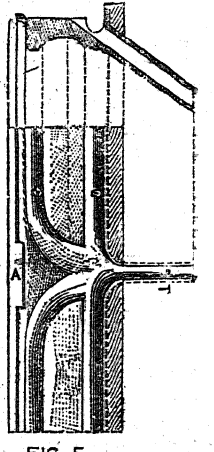


FIG. 5.

DETAILS OF MEETING RAILS FOR FRENCH CASEMENT WINDOWS.

manufacture, for with it a thin shaving or ½in. may be taken off a bar to bring it to exactly the right length to fit right and look right in the particular place it is to go. It is particularly valuable on curved work, as the tables can be swung below the centre if necessary to cut the right way of the grain, and pieces can be fitted in a moment that would require an immense amount of time to whittle out in good shape. Each machine is graduated to instantly show angles of thirty, forty-five, sixty, and ninety degrees, and is equipped with a pair of cutters and corresponding wooden bed pieces, to conform exactly to any style sash-bar desired, and it is ready for work as soon as received. The machine can also be used for mitring or mortising for coping mouldings by having suitable cutters for the work. We give an illustration taken from a photograph of a window on which every joint was made on one of these machines without puttying or whittling; and although we have not space to illustrate one of the machines, Messrs. J. B. Stone and Co. will be happy to show them in actual operation to anyone visiting their works at 135, Finsbury-pavement, London.

A matter also likely to cause trouble to the glazier is the adoption of some sound invention or contrivance for preventing the accumulation of water in the canal usually placed at the joints of French casements to conduct the rain water or condensed moisture out from the inside without draughts or inconvenience. We can best illustrate the known methods by reference to diagrams with figures. The system of M. G. Masson is shown at fig. 1, where the canal is made by a sort of rebate overlapping as the window is closed. This closely resembles Mr. Bertrand's system, save that the projection is formed in different materials.

A piece of indiarubber or gutta-percha is applied in the closing joint of this casement by M. Gouet. The closing of the window, and the pressure of the elastic material, forces out the water, and ensures a perfectly watertight joint. Fig. 2 illustrates a system where wood is chiefly employed by the inventors. The arrangement of the canals to convey away the condensed moisture is clearly seen in the diagrams. Fig. 3 shows in perspective the jointing at the end of the frame. There has also been at different times some attempt made to introduce metallic window frames. Figs. 4 and 5 give the plan of conducting the jet of water formed by the condensed moisture. At fig. 6 the section shows an inclined canal for the same purpose.

One last word, apart from the actual business of the glass worker or fitter, the glazier, in fact. It is in relation to those imitations of stained glass, made by the use of coloured sheets, and known as Diaphanie, Vitremanie, or, still better, the later and widely accepted invention of "Glacier" decoration. Diaphanie, which Vitremanie superseded, was a great success; it had, however, its defects. The sheets being applied with transfer varnish, bubbles of air sometimes remained between the design and the glass, which in the subsequent process of rubbing off the paper resulted in holes; this rubbing off, moreover, required much time, patience, and care, and was rarely perfectly performed. Those who have known and practised Diaphanie, will remember the troublesome and difficult process of removing the superfluous paper at the back after the subject had well adhered to the glass. These defects were obviated by Vitremanie. By this method the designs, after being covered with glucine, may be applied to the glass with water only, and the paper removed entire, a few minutes sufficing for the operation, and nothing being left on the glass but the design in colours of unclouded brilliancy and transparency. To fix these special instructions are necessary.

The arrangement of the designs—produced by lithographic processes, and possessing, when transferred to the glass, all the richness and fulness of colour, as well as transparency, obtained by the most expensive art of glass staining—their proper application, and removing the paper on which they are printed, comprises the whole of this simple art. For the sake of clearness the work may be divided into the following: Preparing and arranging the designs, applying the coloured surface to the glass, removing the paper, and varnishing; the latter being not necessary as to effect, but advisable, as it ensures durability and obviates the risk of damage by scratching. Failure will be impossible if the following directions are closely attended to: Do not crowd each pane with little subjects; do not use a border round each pane, but round the whole window, and let it be not too small, as it will appear, when finished, much narrower than when in the sheet; do not mix the different styles. Use separate glass, and, when finished, fix it into the window by a bead, a few brads, or any similar contrivance. Common sheet glass, flat and free from specks, answers the purpose sufficiently well. When the object is to have as much white light as possible, and the application of the white grounding is considered troublesome, the design may be cut out, and applied to ordinary

engraved glass ; but plain ground glass should never be used. When joins occur, as between subject and grounding, a strip of lead foil, affixed with transferring varnish, should be applied. This is not in all cases necessary, but is always an improvement.

There are some other details of procedure ; many of these, however, being obviated by the introduction of the Glacier decoration, we need not recapitulate them. For this latter decoration, which is most convenient and useful, reference should be made to the manufacturers, Messrs. McCaw, Stevenson, and Orr, of Belfast, who, we are sure, will courteously furnish every particular.

THE END.